

MEMORANDUM

THEORETICAL PERFORMANCE OF LIQUID HYDROGEN WITH

LIQUID OXYGEN AS A ROCKET PROPELLANT

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Tables II(a) through II(h): Add 10,000 to the enthalpy values for R = 0.150 and 0.200 for pressure ratios of 1.00 to 4000.00.

Tables II(a), (c), (d), (e), (g), and (h): Add 10,000 to the enthalpy values for R = 0.250 for pressure ratios of 1.00 to 10.00.

Tables II(b) and (f): Add 10,000 to the enthalpy values for R = 0.250 for pressure ratios of 1.00 to 10.21.

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SUMMARY

Theoretical rocket performance for both equilibrium and frozen composition during expansion was calculated for the propellant combination liquid hydrogen and liquid oxygen at four chamber pressures (60, 150, 300, and 600 lb/sq in. abs) and a wide range of pressure ratios (1 to 4000) and oxidant-fuel ratios (1.190 to 39.683). Data are given to estimate performance parameters at chamber pressures other than those for which data are tabulated. The parameters included are specific impulse, specific impulse in vacuum, combustion-chamber temperature, nozzle-exit temperature, molecular weight, molecular-weight derivatives, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, isentropic exponent, viscosity, thermal conductivity, Mach number, and equilibrium gas compositions.

The maximum value of specific impulse for expansion to 1 atmosphere is given in the following table:

Combustion- chamber	Ratio of chamber	Specific impulse, I, (lb)(sec)/(lb)					
pressure, P _C , lb/sq in. abs	pressure to exit pressure, P _C /P	Assuming frozen composition	Assuming equilibrium composition				
60	4.083	254.6	255.4				
150	10.207	313.1	315.0				
300	20.414	345.8	348.1				
600	40.827	371.8	374.5				

 g_c

INTRODUCTION

The performance of hydrogen and oxygen as a rocket propellant has been reported in the literature. However, additional performance calculations are needed for a wider range of conditions than were heretofore available. Calculations were therefore made at the NASA Lewis Research Center to provide rocket performance data for liquid hydrogen and liquid oxygen for the following conditions:

- (1) Four chamber pressures (60, 150, 300, and 600 lb/sq in. abs)
- (2) A wide range of oxidant-fuel weight ratios (1.190 to 39.683)
- (3) A wide range of pressure ratios (1 to 4000)
- (4) Equilibrium and frozen composition during expansion

Data are given to permit estimates of performance parameters at chamber pressures other than those given in this report.

SYMBOLS

The following symbols are used in this report:

```
nozzle area, sq in.
Α
            number of formula weights (defined as A in ref. 1)
d
            local velocity of sound, ft/sec
a
            coefficient of thrust, C_F = g_c I/c^2 = F/P_c A_t
C_{\mathbf{F}}
            molar specific heat at constant pressure, cal/(mole)(OK)
            specific heat at constant pressure, (\partial h/\partial T)_P, cal/(g)(°K)
c_{p}
            specific heat at constant volume, cal/(g)(^{\circ}K)
c^{2}
e*
            characteristic velocity, g<sub>c</sub>P<sub>c</sub>A<sub>t</sub>/w, ft/sec
F
            thrust, 1b
f_{ij}^{(k)}
            function of T*
```

gravitational conversion factor, $52.174 \left(\frac{\text{lb mass}}{\text{lb force}}\right) \left(\frac{\text{ft}}{\text{cec2}}\right)$

 $H_{\rm T}^{\rm O}$ sum of sensible enthalpy and chemical energy at temperature T, cal/mole

sum of sensible enthalpy and chemical energy per unit mass, $\frac{\sum_i x_i \left(\text{H}_T^o \right)_i}{\text{, cal/g}}, \text{ cal/g}$

I specific impulse with ambient and exit pressures equal, (lb force)(sec)/lb mass

Ivac specific impulse in vacuum, (lb force)(sec)/lb mass

k coefficient of thermal conductivity, cal/(sec)(cm)(°K)

M Mach number

 \mathcal{M} molecular weight, $\sum_{i} x_{i} \mathcal{M}_{i}$, g/g-mole or lb/lb-mole

 n_c* characteristic-velocity exponent, ∂ ln $c*/\partial$ ln P_c

n_I specific-impulse exponent for fixed pressure ratio, $\left(\frac{\partial \ \ln \ I}{\partial \ \ln \ P_c}\right)_{P_C/P}$

 n_{T} temperature exponent for fixed pressure ratio, $\left(\frac{\partial \ln T}{\partial \ln P_{\mathrm{c}}}\right)_{P_{\mathrm{c}}/P}$

 n_{ϵ} area-ratio exponent for fixed pressure ratio, $\left(\frac{\partial \ln \epsilon}{\partial \ln P_{c}}\right)_{P_{c}/P}$

O/F oxidant-fuel weight ratio

P static pressure (sum of partial pressures), lb/sq in. abs

p partial pressure, lb/sq in. abs

Q heat of formation or dissociation

equivalence ratio, ratio of two times the number of oxygen R atoms to the number of hydrogen atoms, 2(0)/(H) universal gas constant (consistent units) A entropy at a pressure of 1 atmosphere, cal/(mole)(°K) Sm $\frac{\sum_{i} x_{i} \left[\left(S_{T}^{\circ} \right)_{i} - \mathcal{R} \ln \left(p_{i} / 14.696 \right) \right]}{\mathcal{M}},$ entropy per unit mass, s $cal/(g)(^{\circ}K)$ temperature OK Т reduced temperature for viscosity calculations (temperature т* divided by force constant (ϵ/k) , kT/ ϵ velocity, ft/sec V specific volume mass-flow rate, lb/sec mole fraction isentropic exponent, $\left(\frac{\partial \ln P}{\partial \ln \rho}\right)_{c}$ Υ correction term for polarity for viscosity calculations δ ratio of nozzle area to throat area ε force constant for viscosity calculation €/k absolute viscosity, g/(cm)(sec) or poises

density, lb/cu in.

o collision diameter for viscosit, calculation

 $\Omega(2,2)^*$ function of T^*

Subscripts:

c combustion chamber

e nozzle exit

i product of combustion

in injector

P constant pressure

P_c/P constant pressure ratio

s constant entropy

T constant temperature

t nozzle throat

l reference point

Superscript:

o thermodynamic standard reference state

CALCULATION OF PERFORMANCE DATA

Theoretical rocket performance data were obtained for liquid hydrogen with liquid oxygen for four chamber pressures over a wide range of oxidant-fuel ratios and pressure ratios assuming both equilibrium and frozen composition during expansion.

The computations were carried out by the method of reference 1 with modifications to adapt it for use with an IBM 650 Magnetic Drum Data-Processing Machine, with index accumulators, high-speed core, and floating-point attachments. The successive approximation process used in the calculations was continued until seven-figure accuracy was reached in the desired values of the assigned parameters (mass balance, pressure, and enthalpy or entropy).

Assumptions

The calculations were based on the following usual assumptions: perfect gas law, adiabatic combustion at constant pressure, isentropic expansion, no friction, homogeneous mixing, and one-dimensional flow. The products of combustion were assumed to be the following ideal gases: atomic hydrogen, H; hydrogen, H2; water, H2O; atomic oxygen, O; oxygen, O2; and the hydroxyl radical, OH.

Initial Data

Thermodynamic data. - The ideal gas thermodynamic properties for atomic hydrogen, hydrogen, atomic oxygen, and oxygen were taken from reference 2. Data for water are also given in reference 2, however, the same data are given to more decimal places in reference 3, and therefore reference 3 data were used. The hydroxyl radical data were taken from reference 4. The values of entropy used in the present report do not include nuclear spin.

Heats of formation or dissociation. - The heats of formation or dissociation for the molecules considered in this report are given in the following table:

Reaction (all substances in	l .	of forma- or dis-	Temper- ature	Refer- ence
gas phase)		tion, Q	of re- action,	
	cm ⁻¹	cal/mole	°K	
Q + H ₂ → 2H	36,116	103,263	0	5
Q + O ₂ -> 20	41,260	117,971	0	6
$H_2 + \frac{1}{2} O_2 \rightarrow H_2 O + Q$		57,797.9	298.16	7
Q + OH → O + H	35,450	101,359	0	8

Where values are given in centimeter⁻¹, they are converted by taking 1 centimeter⁻¹ equivalent to 2.85921 calories per mole, calculated from data given in reference 9. The base used in this report for assigning absolute values to enthalpy is the same as in reference 1.

Viscosity data. - Viscosity data are needed for heat-transfer calculations; however, accurate data for gases as high temperatures are unavailable in the literature. Theoretical considerations of force fields lead to theoretical expressions for viscosity that fit available experimental data fairly well and therefore provide a basis upon which experimental data may be extrapolated into the higher temperature regions.

A detailed treatment of the derivation of various theoretical equations for viscosity is given in references 1.0 and 11. The use of these equations to obtain a refined numerical calculation of viscosity involves the selection of a force-field potential and considerable numerical work. Much of this numerical work can be saved by using tables of collision integrals such as those based on the Lennard-Jones 6-12 potential and the following equation (ref. 11):

$$\mu \times 10^{7} = \frac{266.93 \sqrt{\pi} f_{\mu}^{(k)}}{\sigma^{2}_{\Omega}(2,2)^{*}}$$
 (1)

The parameters $\Omega^{(2,2)*}$ and $f_{\mu}^{(k)}$ for nonpolar gases are tabulated in reference 11 as a function of reduced temperature T^* while $\Omega^{(2,2)*}$ for polar gases ($f_{\mu}^{(k)}$ assumed to be unity) is tabulated in reference 12 as a function of T^* and δ .

The force constants ϵ/k and σ for H_2 , O_2 , and H and ϵ/k , σ , and δ for H_2O were calculated from experimental viscosity data. No experimental viscosity data were found for O and OH. The value of σ for O was estimated from equations in reference 13, and the value of ϵ/k was taken to be equal to that of O_2 . The values of σ and ϵ/k for OH were estimated from the following equations:

$$\sigma_{\text{OH}} = \frac{\sigma_{\text{O}_2} + \sigma_{\text{H}_2}}{2} \tag{2}$$

$$(\epsilon/k)_{OH} = \sqrt{(\epsilon/k)_{O_2}(\epsilon/k)_{H_2}}$$
 (3)

The force constants selected are summarized in the following table:

Sub- stance	σ, 8	e∕k, ^O K	δ	Refer- ence
Н	2.497	99.8		a ₁₄
Н2	2.729	86.1		a ₂
H ₂ O	3.487	126.3	2.409	a ₁₅
0	3.068	102.2		b ₁₃
02	3.490	102.2		a ₂
ОН	3.110	93.8		(c)

^aCalculated from data in reference given.

bo Estimated from equations in reference given and ϵ/k assumed equal to that of 0_2 .

^cEstimated by means of equations (2) and (3).

Physical and thermochemical data. - Several physical and thermochemical properties of the propellants are listed in table I. Additional properties of hydrogen may be found in references 16 and 17 while properties of oxygen may be found in reference 18.

FORMULAS

The formulas used in computing the various performance parameters are as follows:

Specific impulse with ambient and exit pressures equal, (lb force)(sec)/lb mass:

$$I = 294.98\sqrt{\frac{h_{c} - h_{e}}{1000}}$$
 (4)

Specific impulse in vacuum, (lb force)(sec), lb mass:

$$I_{\text{vac}} = I + P\left(\frac{A}{w}\right) \tag{5}$$

Nozzle area per unit mass-flow rate, (sq in)(sec)/lb:

$$\frac{A}{W} = \frac{86.4554 \text{ T}}{PMI} \tag{6}$$

Throat area per unit mass-flow rate, (sq in)(sec)/lb:

$$\frac{A_t}{w} = \frac{2781.6 T_t}{P_t \mathcal{A}_t a} \tag{7}$$

This equation is derived from the continuity equation and the fact that velocity of flow equals velocity of sound at the throat.

Velocity of sound, ft/sec:

$$a = \sqrt{\left(\frac{\partial P}{\partial \rho}\right)_{S}} = \sqrt{\frac{P}{\rho} \left(\frac{\partial \ln P}{\partial \ln \rho}\right)_{S}} = 299.16 \sqrt{\left(\frac{T}{\lambda}\right) \left(\frac{\partial \ln P}{\partial \ln \rho}\right)_{S}}$$
(8)

Characteristic velocity, ft/sec:

$$c^* = g_c P_c \frac{A_t}{w} = 32.174 P_c \frac{A_t}{w}$$
 (9)

Coefficient of thrust:

$$C_{\mathbf{F}} = \frac{g_{\mathbf{C}}^{\mathbf{I}}}{c^{*}} = \frac{32.174 \text{ I}}{c^{*}}$$
 (10)

Ratio of nozzle area to throat area

$$\epsilon = \frac{A/w}{A_t/w} \tag{11}$$

Partial Derivatives .

The derivatives of the fundamental thermodynamic quantities have many useful applications. Equations (24) to (27) are examples of these applications.

All the relations between first derivatives may be expressed in terms of three arbitrary first derivatives in addition to the fundamental quantities. The three derivatives selected for this report are $(\partial h/\partial T)_P = c_p$, $(\partial \ln \mathcal{M}/\partial \ln T)_P$, and $(\partial \ln \mathcal{M}/\partial \ln P)_T$. Specific heat c_p is needed in heat-transfer calculations and the other two derivatives are a useful indication of the extent of dissociation.

These derivatives were obtained by means of the following equations:

$$c_{p} = \frac{1}{P \mathcal{M} T} \left[\sum_{i} p_{i} (H_{T}^{O})_{i} \left(\frac{\partial \ln p_{i}}{\partial \ln T} \right)_{p} - \mathcal{M} h \left(\frac{\partial \ln \mathcal{M}}{\partial \ln T} \right)_{p} + T \sum_{i} p_{i} (C_{p}^{O})_{i} \right]$$
(12)

$$\left(\frac{\partial \ln \mathcal{M}}{\partial \ln P}\right)_{T} = \frac{P}{\sum_{i} p_{i} \left(\frac{\partial \ln p_{i}}{\partial \ln \mathcal{M}}\right)_{T}} - 1 \tag{13}$$

$$\left(\frac{\partial \ln \mathcal{M}}{\partial \ln T}\right)_{P} = \left(\frac{\partial \ln \mathcal{M}}{\partial \ln T}\right)_{P} \tag{14}$$

where $(\partial \ln p_i/\partial \ln T)_P$, $(\partial \ln \mathscr{A}/\partial \ln T)_P$, and $(\partial \ln p_i/\partial \ln \mathscr{A})_T$ are found by matrix methods similar to those described for obtaining $(\partial \ln p_i/\partial \ln T)_s$ in reference 1, and where \mathscr{A} is A in reference 1.

Reference 19 presents a convenient scheme for expressing all first derivatives in terms of $(\partial v/\partial T)_p$, $(\partial v/\partial P)_m$, and $(\partial h/\partial T)_p = c_p$. By means

of the following equations, $(\partial v/\partial T)_P$ and $(\partial v/\partial P)_T$ can be obtained from the derivatives given in this report:

$$\left(\frac{\partial \mathbf{v}}{\partial \mathbf{T}}\right)_{\mathbf{P}} = -\frac{\mathbf{v}}{\mathbf{T}} \left[\left(\frac{\partial \ln \mathcal{M}}{\partial \ln \mathbf{T}}\right)_{\mathbf{P}} - 1 \right] \tag{15}$$

$$\left(\frac{\partial \mathbf{v}}{\partial \mathbf{P}}\right)_{\mathbf{T}} = -\frac{\mathbf{v}}{\mathbf{P}} \left[\left(\frac{\partial \ln \mathbf{M}}{\partial \ln \mathbf{P}}\right)_{\mathbf{T}} + 1 \right] \tag{16}$$

With the aid of the tables in reference 19 and equations (15) and (16), other first derivatives can be expressed in terms of c_p , (3 ln $\mathcal{M}/3$ ln T)_P, and (3 ln $\mathcal{M}/3$ ln P)_T. Some examples are,

$$c_{v} = c_{p} - \frac{\mathcal{A}}{\mathcal{A}} \frac{\left[1 - \left(\frac{\partial \ln \mathcal{A}}{\partial \ln T}\right)_{p}\right]^{2}}{1 + \left(\frac{\partial \ln \mathcal{A}}{\partial \ln P}\right)_{m}}$$
(17)

$$\gamma = \left(\frac{\partial \ln P}{\partial \ln \rho}\right)_{S} = \frac{2p}{c_{P} \left[1 + \left(\frac{\partial \ln M}{\partial \ln P}\right)_{T}\right] - \frac{R}{M} \left[1 - \left(\frac{\partial \ln M}{\partial \ln T}\right)_{P}\right]^{2}} (18)$$

or

$$\gamma = \frac{c_p}{c_v} \left[\frac{1}{1 + \left(\frac{\partial \ln \mathcal{M}}{\partial \ln P} \right)_m} \right]$$
(19)

When composition is frozen,

$$\left(\frac{\partial \ln \mathcal{M}}{\partial \ln P}\right)_{T} = \left(\frac{\partial \ln \mathcal{M}}{\partial \ln T}\right)_{P} = 0$$
(20)

and equations (17) and (18) reduce to

$$c_v = c_p - \frac{\mathcal{R}}{\mathcal{M}}$$

and

$$\gamma = \frac{c_p}{c_p - 2} = \frac{c_p}{c_{r,r}}$$
 (21)

Viscosity of Mixtures

Viscosities of multicomponent mixtures calculated by rigorous methods (refs. 11 and 20) show excellent agreement with experimental data. However, these calculations involve considerable effort and become increasingly more difficult with increasing number of components. Simpler techniques, but which still involve considerable calculations, are given in references 21 and 22.

The following equation, based on averaging kinematic viscosities, gives approximate results, which are often sufficiently accurate for engineering purposes:

$$\mu = \frac{\mathcal{M}}{\sum_{i} \frac{x_{i} \mathcal{M}_{i}}{\mu_{i}}} \tag{22}$$

The equation appears adequate until better high-temperature data for the individual components become available.

Conductivity

Thermal conductivities as well as viscosities are needed in heattransfer calculations. However, experimental conductivity data are generally even less available than experimental viscosity data. Therefore, the Eucken relation

$$k = \mu \left(c_p + \frac{5}{4} \frac{\mathcal{R}}{\mathcal{M}} \right) \tag{23}$$

which often gives satisfactory values of conductivity for individual components, is used in this report to estimate the conductivity of gaseous mixtures.

THEORETICAL PERFORMANCE DATA

Tables

The calculated values of the various performance parameters for combustion pressures of 60, 150, 300, and 600 pounds per square inch absolute and for a range of equivalence ratios and exit conditions are given in tables II to V. Table II presents performance data at assigned pressure ratios from 1 to 4000 for equivalence ratios from 0.15 to 5.00 (oxidant-fuel weight ratios from 1.190 to 39.683). Properties at the throat may be found where $\epsilon = 1.00$. Table III gives various thermodynamic partial

derivatives. Equilibrium composition in the combustion chamber and at the assigned exit conditions is given in table IV. Characteristic velocity and summary of the performance parameters at an exit pressure of l atmosphere are presented in table V.

Curves

The performance parameters are plotted in figures 1 to 8. Curves of specific impulse are presented in figure 1 for assigned pressure ratios as functions of percent by weight of fuel. Combustion temperature and exit temperature for assigned pressure ratios are plotted in figure 2 as functions of percent by weight of fuel. Curves of the ratio of nozzle area to throat area are plotted in figure 3 as functions of percent by weight of fuel for assigned pressure ratios. Figure 4 gives the curves for coefficient of thrust for assigned pressure ratios as functions of percent by weight of fuel; figure 5 presents curves of molecular weight for assigned pressure ratios; and figure 6 presents curves of characteristic velocity as functions of percent by weight of fuel. Figure 7 gives curves of specific impulse in vacuum for assigned area ratios as functions of percent by weight of fuel. The curves of figure 7 were obtained by interpolation of the data at assigned pressure ratios.

Effect of Assuming Frozen or Equilibrium Composition During Expansion

A comparison of specific impulse data based on equilibrium and frozen composition during expansion to an exit pressure of l atmosphere is given in figure 8. A comparison of maximum calculated values of specific impulse based on equilibrium and frozen composition during expansion is shown in the following table for expansion to l atmosphere and to pressure ratios of 100 and 4000 (taken from table II):

Chamber pressure, P_c , lb/sq in.		Equivalence ratio, R, at which I is maximum	Oxidant- fuel weight ratio, O/F	Composition during expansion	Maximum specific impulse, I, (lb)(sec)	Differ- ence in I, percent
aus			,		lb	
60	4.083	0.35 .35	2.778 2. 7 78	Equilibrium Frozen	255.4 254.6	0.31
	100	0.45 .40	3.571 3.175	Equilibrium Frozen	400.8 394.2	1.67
	4000	0.70 .40	5.556 3.175	Equilibrium Frozen	465.9 448.8	3.81
150	10.207	0.40 .35	3.175 2.778	Equilibrium Frozen	315.0 313.1	0.61
	100	0.50 .40	3.968 3.175	Equilibrium Frozen	401.3 395.7	1.42
	4000	0.70 .45	5.556 3.571	Equilibrium Frozen	466.6 451.4	3.37
300	20.414	0.45 .40	3.571 3.175	Equilibrium Frozen	348.1 345.8	0.67
	100	0.50 .40	3.968 3.175	Equilibrium Frozen	401.5 396.6	1.24
	4000	0.70 .45	5.556 3.571	Equilibrium Frozen	467.0 453.3	3.02
600	40.827	0.50 .40	3.968 3.175	Equilibrium Frozen	374.5 371.8	0.73
	100	0.50 .45	3.968 3.571	Equilibrium Frozen	401.7 397.5	1.06
	4000	0.70 .50	5.556 3.968	Equilibrium Frozen	467.4 454.9	2.75

The preceding table shows that for pressure ratios up to 100, the difference in maximum specific impulse due to equilibrium or frozen composition during expansion is less than 2 percent. For a pressure ratio of 4000 the difference increases to 3 to 4 percent. However, the maximum specific impulse occurs in general at a higher oxidant-fuel ratio 0/F for equilibrium composition than for frozen composition.

A comparison of values composition at the same O/F from data in table II, for

specific impulse for frozen and equilibrium ould show larger differences. For example, amber pressure of 60 pounds per square inch absolute, a pressure ratio of 4000, an 0/F of 5.556 (where equilibrium specific impulse is maximum) the difference in specific impulse for frozen and equilibrium composition is 9.6 percent. For the same conditions but for the stoichiometric 0/F of 7.937, the difference is 15.8 percent. This is the largest difference between frozen and equilibrium specific impulse at constant 0/F for any of the conditions in this report.

The O/F for maximum specific impulse increases with increasing pressure ratio. For fixed pressure ratios and frozen composition the O/F for maximum specific impulse increases with increasing chamber pressure.

Effect of Chamber Pressure

By use of suitable exponents, performance parameters can be estimated with good accuracy at chamber pressures other than those given in this report. The logarithmic values of the parameters I, $I_{\rm vac}$, T, ϵ , and c* are very nearly linear with the logarithm of chamber pressure for a fixed equivalence ratio and pressure ratio or fixed equivalence ratio and area ratio. This linearity permits the data to be extended by means of exponential equations.

In the case of equilibrium composition, the following analytic expressions were derived that permit the exponents to be computed from data at a single chamber pressure:

$$n_{I} = \left(\frac{\partial \ln I}{\partial \ln P_{c}}\right)_{P_{c}/P} = 86.4554 \frac{I'}{I^{2}} \left(\frac{1}{\mathcal{M}_{c}} - \frac{1}{\mathcal{M}}\right)$$
(24)

$$n_{T} = \left(\frac{\partial \ln T}{\partial \ln P_{c}}\right)_{P_{c}/P} = \frac{\mathcal{R}}{\mathcal{A}c_{p}} \left[1 - \left(\frac{\partial \ln \mathcal{A}}{\partial \ln T}\right)_{P}\right] - \frac{\mathcal{R}}{c_{p}\mathcal{A}_{c}}$$
(25)

$$n_{\epsilon} = \left(\frac{\partial \ln \epsilon}{\partial \ln P_{c}}\right)_{P_{c}/P} = (n_{A/w})_{e} - (n_{A/w})_{t}$$
 (26)

where

$$n_{A/w} = \left(\frac{\partial \ln A/w}{\partial \ln P_{c}}\right)_{P_{c}/P} = -\frac{\mathcal{R}}{c_{p}\mathcal{M}_{c}} \left[1 - \left(\frac{\partial \ln \mathcal{M}}{\partial \ln T}\right)_{P}\right] - \frac{1}{\gamma} - n_{I}$$

$$n_{c}* = \frac{\partial \ln c^{*}}{\partial \ln P_{c}} = 1 + (n_{A/w})_{t}$$
(27)

$$n_{I_{vac}} = \left(\frac{\partial \ln I_{vac}}{\partial \ln P_c}\right)_{P_c/P} = \frac{I(n_I - n_c * - n_\epsilon)}{I_{vac}} + n_c * + n_\epsilon \tag{28}$$

Equations (24) to (28) may be written in the approximate form:

$$I = I_1 \left(\frac{P_c}{P_{c,1}}\right)^{n_{I,1}} \tag{29}$$

$$T = T_1 \left(\frac{P_c}{P_{c,1}}\right)^{n_T,1} \tag{30}$$

$$\epsilon = \epsilon_1 \left(\frac{P_c}{P_{c,1}} \right)^{n_{\epsilon,1}} \tag{31}$$

$$c^* = c_1^* \left(\frac{P_c}{P_{c,1}} \right)^{n_c^*, 1}$$
 (32)

$$I_{\text{vac}} = I_{\text{vac},1} \left(\frac{P_{\text{c}}}{P_{\text{c},1}} \right)^{n_{\text{I}_{\text{vac},1}}}$$
(33)

where $P_{c,1}$ may be either 60, 150, 300, or 600 pounds per square inch absolute provided that I_1 , T_1 , ϵ_1 , c_1^* , $I_{vac,1}$, and their derivatives are the corresponding values for the chamber pressure selected.

The exponents obtained by means of equations (24) to (28) are shown in table III.

In order to illustrate the use of these derivatives, suppose it is desired to obtain the value of equilibrium specific impulse for a chamber pressure of 1200 pounds per square inch absolute and a pressure ratio of 81.65 (exit pressure, 1 atm) for an equivalence ratio R of 0.90 (0/F = 7.143): From table III, the value of I at this pressure ratio and equivalence ratio (but for a chamber pressure of 600 lb/sq in. abs) is 376.8 and the value of $n_{\rm I}$ is 0.0079. From equation (29),

$$I = 376.8 \left(\frac{1200}{600}\right)^{0.0079}$$
$$= 376.8 (1.0055)$$
$$= 378.9$$

A comparison of the parameters obtained by means of the chamber-pressure correlation and by a direct calculation is given in the following table (R = 0.90, equilibrium composition during expansion):

Parameter	Chamber pressure, P _c , 1200 lb/sq in. abs; Exit pressure, P, 1 atm						
	Estimated Direct by correlation lation		Error				
I	378.93	378.86	0.07				
T _c	3623.3	3622.0	1.3				
T _e	2338.4	2338.6	.2				
€	11.769	11.755	.014				
e*	7306.1	7304.7	1.4				

It is expected that values estimated for other equivalence ratios and pressure ratios for chamber pressures from about 30 to 1200 pounds per square inch absolute will have small errors of the order of magnitude shown in the previous table.

The following analytic expressions were derived for equilibrium composition which permit exponents to be computed similar to those in equations (24) to (28) but for constant area ratio rather than constant pressure ratio (eqs. 34, 37, 38, 40):

$$\left(\frac{\partial \ln P_{\rm c}/P}{\partial \ln P_{\rm c}}\right)_{\epsilon} = n_{\epsilon} / \left(\frac{\partial \ln \epsilon}{\partial \ln P}\right)_{\rm s}$$
(34)

where

$$\left(\frac{\partial \ln \epsilon}{\partial \ln P}\right)_{S} = -\frac{1}{\gamma} - \left(\frac{\partial \ln I}{\partial \ln P}\right)_{S} \tag{35}$$

and

$$\left(\frac{\partial \ln I}{\partial \ln P}\right)_{S} = -86.4554 \frac{T}{I^{2}} \quad \text{or} \quad 1 - \frac{I_{\text{vac}}}{I}$$
 (36)

$$\left(\frac{\partial \ln I}{\partial \ln P_{c}}\right)_{\epsilon} = n_{I} - \left(\frac{\partial \ln I}{\partial \ln P_{c}}\right)_{s} \left(\frac{\partial \ln P_{c}/P}{\partial \ln P_{c}}\right)_{\epsilon}$$
(37)

$$\left(\frac{\partial \ln T}{\partial \ln P_{c}}\right)_{\epsilon} = n_{T} - \left(\frac{\partial \ln T}{\partial \ln P}\right)_{s} \left(\frac{\partial \ln P_{c}/P}{\partial \ln P_{c}}\right)_{\epsilon}$$
(38)

where

$$\left(\frac{\partial \ln T}{\partial \ln P}\right)_{S} = \frac{\mathcal{A}}{\mathcal{M}c_{p}} \left[1 - \left(\frac{\partial \ln \mathcal{M}}{\partial \ln T}\right)_{P}\right] \tag{39}$$

$$\left(\frac{\partial \ln I_{\text{vac}}}{\partial \ln P_{c}}\right)_{\epsilon} = n_{I_{\text{vac}}} - \left(\frac{\partial \ln I_{\text{vac}}}{\partial \ln P}\right)_{s} \left(\frac{\partial \ln P_{c}/P}{\partial \ln P_{c}}\right)_{\epsilon}$$

$$= \frac{I(n_{I} - n_{c}*)}{I_{\text{vac}}} + n_{c}*$$
(40)

where

$$\left(\frac{\partial \ln I_{\text{vac}}}{\partial \ln P}\right)_{s} = \left(\frac{\partial \ln \epsilon}{\partial \ln P}\right)_{s} \left(1 - \frac{I}{I_{\text{vac}}}\right) \tag{41}$$

Data for constant area ratios for chamber pressures other than those given in this report may be obtained in a manner similar to the previous example by interpolating the data in table II (see, for example, fig. 7) together with exponents obtained from equations (34) to (41).

Effect of Finite Chamber Area

The use of a combustion chamber of finite cross-sectional area leads to a pressure change during the combustion process. For a cylindrical

chamber, the injector face pressure P_{in} may be found from the following equation derived from the conservation of the momentum

$$P_{in} = P_{l} + \frac{w}{A_{l}g_{c}} (V_{l} - V_{in})$$
 (42)

where P_1 and V_1 are the static pressure and velocity at the nozzle entrance, respectively, and $V_{\rm in}$ is the average velocity of propellant (liquid or gas) in the axial direction when injected. Equation (42) may be written

$$P_{in} = P_c \left(\frac{P_l}{P_c}\right) (I_l g_c - V_{i,n})$$
 (43)

where P_c is the stagnation pressure in the nozzle.

In order to illustrate this, consider a rocket operating at an equivalence ratio of 1.00, a nozzle stagnation pressure of 600 pounds per square inch absolute, a ratio of chamber area to throat area ϵ of 2.122, and $V_{\rm in} = 100$ feet per second. From table II, corresponding to an area ratio of 2.122, $P_{\rm c}/P_{\rm l}$ is 1.05 and I is 43.3. From table V, c* is 7039. Therefore, for these conditions, using equation (43),

$$P_{in} = 600 \left(\frac{1}{1.05}\right) + \frac{600}{7039(2.122)} [(43.3)(32.17) - 100]$$

$$= 571.4 + 51.9$$

$$= 623.3 \text{ lb/sq in. abs}$$

SUMMARY OF RESULTS

A theoretical investigation of the performance of liquid hydrogen with liquid oxygen was made for the following conditions: (1) equilibrium and frozen composition during expansion, (2) four chamber pressures (60, 150, 300, and 600 lb/sq in. abs), (3) wide range of oxidant-fuel weight ratios (1.190 to 39.683), and (4) wide range of pressure ratios (1 to 4000).

1. The maximum values of specific impulse for expansion to 1 atmosphere are summarized in the following table:

Chamber pressure,	Ratio of chamber	Specific in (lb)(se	
P _c , lb/sq in. abs	I CO EVIC I	Equilibrium composition	Frozen composition
60	4.083	255.4	254.6
150	10.207	315.0	313.1
300	20.414	348.1	345.8
600	40.827	374.5	371.8

The maximum value of specific impulse for a chamber pressure of 600 pounds per square inch absolute and a pressure ratio of 4000 is 467.4 and 454.9 assuming equilibrium and frozen composition, respectively.

- 2. The difference between maximum values of specific impulse due to the assumption of equilibrium or frozen composition during expansion is less than 2 percent for pressure ratios up to 100 and about 3 to 4 percent for a pressure ratio of 4000.
- 3. For the same oxidant-fuel ratios, the difference between values of specific impulse due to the assumption of equilibrium or frozen composition during expansion may be as high as 15.8 percent for the conditions in this report.

Lewis Research Center

National Aeronautics and Space Administration Cleveland, Ohio, March 2, 1959

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TABLE I. - PROPERTIES OF LIQUID PROPELLANTS

Properties	Hydrogen	Oxygen
Molecular weight,	2.016	32.00
Density, g/cc	a _{0.0} 709 (at -252.7° C)	b _{1.1414} (at -182.0° C)
Freezing point, ^O C	c _{-259.20}	c-218.76
Boiling point, °C	c _{-252.77}	c _{-182.97}
Enthalpy required to convert liquid at boiling point to gaseous elements at 25°C, kcal/mole	d _{1.694}	d3.081
Enthalpy of vaporization, kcal/mole	c _{0.216} (at -252.77° C)	c _{1.630} (at -182.97° C)
Enthalpy of fusion, kcal/mole	co.028 (at -259.20° C)	c _{0.106} (at -218.76° C)

aRef. 23.

^bRef. 24.

^cRef. 7.

dRef. 1.

TABLE II. - THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(a) Combustion-chamber pressure, 60 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio, P _c /P	Static pressure, P, Ib/sgin.	Temp- erature, T,	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat, c _{p.}	Viscos- ity, μ, micro	Thermal conductivity,	Mach number M	Specific impulse in vacuum, I _{vac}	Areα ratio, ε	Thrust coefficient, C _f	Specific impulse I,
'c / '	obs	°K				cal/{g}("K "	poises	cai/(sec)(°K)(cm)		(lb)(sec)/lb		l	:
			R	= 0.150	, PERCE	NT FUEL	= 45•	55. J/F	= 1.190	0			
1.00	60.00	1103	5313.5	4.416	1.3395	1.7753	314	0.00073	0.000			0.000	0.
1.05	57.14	1166	5287.7	4.410	1.3400	1.7711	311	•00073	•271 •527	530 · l	2.250 1.297	•210 •403	90.
1.20	50.00	1129	5216.6	4.416	1.3456	1.7597	293 293	•00070 •00068	.722	296.1	1.081	.543	122.
1.40	42.86 37.50	1085	5141.8 5077.7	4.416	1.3469	1.7369	285	•00066	.860	286.6	1.018	.636	143.
1.60	32.17	1008	2006.6	4.416	1.35∠7	1.7257	276	•00063	1.000	284·1	1.000	. 725	163.
2.00	30.00	989	4975.4	4.410	1.3540	1.7210	474	•00062	1.059	284.4	1.003	.761	171.
4.00	15.00	824	4693.4	4.416	1.3601	1.6525	234	•00052 •00052	1.575	301.7 302.3	1.233 1.244	1.031	232.
4.08	14.70	819	4682.8	4.410	1,3654	1.6816	232	.00052	1.017	1 302.5	****	**020	
10.00	6.00	643	4392.5	4.416	1.3748	1.6507	180	•00042	2.152	327.5	1.974	1.257	203.
20.00	3.00	532	4209.8	4.416	1.3000	1.6343	157	•0003>	2.086	343.5	2.983 4.620	1.376	309.
40.00	1.50	439	4058.9	4.416	1.3824	1.6200	133	•00049	34031	3,00.4	4.020	1.40.	3300
100.00	•60	340	3899.0	4.416	1.3800	1.6099	104	•00023	3.648	369.8	8.432	1.558	• 50 د
200.00	•30	280	3802.6	4.416	1.3930	1.5951	85	•00018	4.148	377.7	13.431	1.610	362
400-00	•15	230	3723.2	4.416	1.4064	1.5573	70	•00015	4.675	184.1	21.488	1.032	
	0.4	175	3640.1	4.410	1.4339	1.4871	52	.00011	2.440	190.6	39.928	1.694	381.
000.00	•06 •03	142	3590.9	4.416	1.4544	1.4402	45	•00009	6.098	394.3	63.572	1.719	387.
000.00	•02	114	3551.2	4.416	1.4680	1.4116	36	•00007	6.851	397.3	100.939	1.739	391
				1 = 0 • 2 0 C	. PERCE	NT FUEL	= 38.	45. 0/F	= 1.58	7			
					1.3077	1.6194	404	0.00084	0.000			0.000	0
1.00	60+00 57+14	1514	2969.7 2941.7	5.216 5.216	1.3077	1.6194	399	•00083	•274	252.1	2.233	. 209	49.
1.05	50.00	1450	2866.8	5.216	1.3119	1.6028	389	•000å1	. > 3 3	348.6	1.289	•400	94.
1.40	42.86	1378	2783.1	5.216	1.3134	1.5091	578	•0007B	.730		1.077	• 5 3 9	149
1.60	37.50	1354	2713.2	0.216	1.3184	1.5774	369	•00076	1.000		1.016	.632 .716	169
1.85	32.49	1307	2640.5	5.216 5.216	1.3217	1.5653	359 353	•00073 •00072	1.068		1.004	.757	179
2.00	30.00 15.00	1282	2601.1 2290.0	5.216	1.3391	1.5046	307	•00061	1.572		1.244	1.029	243
4.00	14.70	1075	2281.6	5.216	1.3395	1.5031		•00061	1.085		1.256		244.
				!						344.7	2.009	1.257	297.
10.00	6.00	852	1954.3	5.216	1.3559	1.4516	251	+00048	2.148		3.049	1.379	323
20.00 40.00	3.00 1.50	709	1748.8	5.216	1.3714	1.4057		•00034	3.010		4.739		348
40.00		: "	151110		!							1 545	470
100.00	• 60	428	1396.3	5.216	1.3710	1.3916	117	+00026	3,619	390.5	8.679 13.670		370
200 • 00 400 • 00	•30	37×	1286.1	2.210	1.3011	1.300/	96	•00018	4.038		42.270		273
400.00	•17	7.1	11/201	,,,,,,					!				1
000.00	•06	242	1040.4	5.210	1.3973	1.3290	74	•00011	: 5.394 6.015	413.4	41.979 57.667		
000.00	•02 •02	198	993.9	5.216	1.4148	1.2774	>0		6.704		108.705	1.754	
000.00			•	i	i	1	I	<u> </u>	i	1	i	1	1
			F	R = 0.250		ENT FULL	г	T .	= 1•98 I	-1		11.7	
1.00	60.00		1249.3	6.015	1.2812		481	0.00092 .00091	0.000	563.4	2.218	0.000	
1.05	57.14		1220.2	5.016 5.015	1.2824	1.5036	467	•00009	238	330.4	1.283		
1.40	50.00 42.86	1686	1054.0	5.016	1.2809	1.4751		.00086	.736	د 16 د	1.075	.536	
1.60	37.50	1636	981.5	6.016	1.2919	1.4630	446	-00084	•876		1.015		
1.83	32.78	1587	910.0	6.016	1.2948	1.4513			1.000		1.000		
2.00	30.00	1555	864.0	6.016	1.2908	1.4436		•00000	1.076	305.1	1.005		
4.00	15.00	1322	535.1 526.2	6.016	1.3125	1.3875	578 577				1.268		
4.08	14.70	1316	32002	0.010			-	100011	İ		İ		1
10.00	6.00	1007	176.1	6.015	1.3329	1.3226			2.147		3.127	1.258	
20.00	3.00	887	9954.0 9768.1	6.016	1.3461	1.2848		•00046 •00038	2.987		4.883		
40.00	1.50	741	9168.1	0.010	1.3309	1.2339	220	00050	2.00	1		1	
100.00	•60	581	9569.1	6.016	1.3003	1.2021		•00030	3.581		8.985		
200.00	•30	482	9447.8	6.016	1.5717	1.2190			4.063		14.396 23.208		
400-00	•15	399	9347.3	0.010	1.5195	1.02100	***	100020	1	_			
000.00	.06	310	9240.0	6.016	1.3023	1.1943		•00012			43.894		
000.00	. 03	256	9175.9	0.010	1.3806	1.1003					71.2/9		
000.00	•02	∠10	9122.7	6.016	1.4037	1.140/	04	•00010	3.000	13.00	1130000		1
				K = 0.30	O. PERC	ENT FULL	= 29.	57, U/F	= 2+38	1			
1.00	60.00	2089	9932.7	6.812	1.2520	1.4578			0.000	i	1	0.000	0
1.05	57.14	2069	9903.2	6.812	1.2764	1.4493	546						
1.20	>0.00	2015	9823.7	6.813							1.277		
1.40	42.86		9734.6	6.814						310-2			
1.60 1.82	37.50 33.04		9599.7						1.000	200.2	1.000	•700	172
2.00	00•00 ا		9539.2	6.015	1.2734	1.3023	490	-0000-6	1.003	304.0	1.000		
4.00	15.00	1503	9200•0	0.010	1.2830						1.270		
4.08	14.70	1546	9140.8	0.015	1.2890	1.2772	44:	•00074	1.578	, ,,,,,,	1.219	1.00	
10.00	6.00	1228	5520.5	5.010	1.5074	1.2357	97:		2 - 146	961.6	2.085		
50.00	3.00		002344	0.010	1.3240	1.1071	34:	1<000	2.000	20106	3.20	1.300	
40.00	1.50		8373.5			اد داه؛	. 27:	•00042	2.765	37.0	>.038	1.485	365
100.00		708	8180.5	6.510	1.3030	1.11/4	. 22:	د د 000٠٠ ا	5.243				
200.00	1 .50		8180.5		1.3004	1.1005	15		4.01:	423.3	14.995	1.044	404
400.00	15									431.2	24.237	7 1.689	416
	İ				1 1 2/2-	1.0745	120	-00017	5.246	439.6	46.00	1.736	428
	•06		7824.9		1.3/23		120						435
000.00	•03	317	1754.4	0.010		1 1 1 0 0 4 2				448.7			44i

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID DXYGEN

(a) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	fsentropic exponent,	Specific heat, c _{p.}	Viscos- ity, μ,	Thermal conductivity,	Mach number	Specific impulse in vacuum,		Thrust coefficient C _F	Specific impulse I,
P _e /P	lb/sqin. obs	°K	col/g	100t	γ	col/(g)(°K)	micro poises	col/(secH ^o K)(cm)	M	I _{vac.} (fb)(sec)/lb	Ε	C,	(lb)(sec)/(l
				. = 0.350	PERCE	NT FUEL	L	i	= 2+77			4	
		2329	8892.8	7.597	1.2267	1.4897	508	0.00-10	0.000			0.000	0 • 0
1.00	60.00 57.14	2309	8863.2	7.599	1.2284	1.4752	605	-00.09	-282	568.4	2.189	• 204	50.
1.20	50.00	2253	8783.6	7.602	1.2350	1.4362		•00-05	-546	360.3	1.270		
1.40	42.86	2189	8694.1 8618.7	7.606 7.608	1.2302	1.3799	585 575	•00:01 •00(98	.749 .890	320.7	1.067 1.012	.530 .622	131.
1.60	37.50 33.32	2133	8553.6	7.610	1.2462	1.3475		•00095	1.000	309.7	1.002		
2.00	30.00	2042	8497.1	7.611	1.2494	1.3289	559	•00092	1.090	310.6	1.007	.747	185.6
4.00	15.00 14.70	1772	8152.4	7.615 7.615	1.2679	1.2391		•00079 •00079	1.589	333.1	1.277	1.022	253.6
4.00	14.70	1104	014310	,,,,,	1112004	1123,1						1	
10.00	6.00	1452	7768.0	7.616	1.2862	1.1665		•00065	2.147	365.5	2.121 3.285	1.260	312.6
40.00	3.00 1.50	1239	7520.0	7.616 7.616	1.3035	1.1208	381	+00055 +00046	2.951		5.194	1.491	370.
				_	1 :					1			
100.00	•60	838 703	7093.2	7.616	1.3364	1.0120	268 226	•00036 •00030	3.509		9.687 15.643	1.594	395.
400.00	•30 •15	567	6837.8		1.3552	.9954	189	.00025	4.451		25.377	1.703	422.9
ļ						_	l			i <u>.</u>			
1000.00	•06	460	6713.2	7.616 7.616	1.3634	.9790 .9694	148	•00(19 •00(16	5.159	447.5 452.8	48.339 78.934	1.754	435.5
2000.00 ! 4000.00 !	•03	382 317	6637.2	7.616	1.3733	.9600	98	•00(13		457.2	129.082	1.809	449.
		L		= 0.400	05065	NT FUEL	- 22.0)5. /F	L = 3•175	il	l		1
	45.5	25.23	r	8.363	1.1996	1.6075	656	0.00:25	0.000			0.000	0.0
1.00	60+00 57+14	2531	8050+5 8021+3	8.366	1.2011	1.5870	653	•00:23	.286	565.1	2.173	.203	50.4
1.20	>0∙00	2458	7942.5	8.374	1.2025	1.5334	645	•00.18	•>54	358.7	1.263	.390	96.9
1.40	42.86	2376	7053.8	8.383	1.2107	1.4758	635	•00.13 •00.08	.756	19.7 و 10.8 د	1.063 1.010	.526 .618	153.
1.78	37.50 33.62	2342	7778.0	8.389 8.393	1.2153	1.3954		00.05	1.000	309.2	1.000	.683	169.
2.00	30.00		7657.4	8.397	1.2232	1.3620	611	•00:01	1.098		1.008	.744	184.
4.00	15.00	1978	7311.0	6.411	1.2458	1.2147	561 559	•00(85	1.594	333.8	1.289		253.
4.08	14.70	1970	7301.4	8.411	1.2464	1.2110	259	•00(84	1.007	334.0	10002	1.02	233.
10.00	6.00	1640	6920.2	8.416	1.2689	1.1161		•00€69			2.160		313.
20.00	3.00	1411	6670.9	8.416	1.2839	1.0681	435 381	•00(59 •00(50	2.540	388.3 405.7	3.365 5.356		346.
40.00	1.50	1207	6457.0	0.410	102770	110279	201	*000.50	2.734	40241	, ,,,,,,		
100.00	•60	972	6222.0	8.416	1.3100	•9772	313	•00(40	3.476	423.9	10.068		398.
200.00	• 30	820 689	6075.6 5952.4	8.416	1.3316	.9481 .9252		•00(33 •00(27	3.914 4.384	434.9	16.345	1.667	414.
400.00	•15	007	3932.4	0.410	1.5420	• 72.72		******	!				į.
1000 • 00	•06	543	5819.7		1.3535	•9041		•00(21	5.068	453.3	50.955		440.6
4000-00	•03 •02		5738.3	0.410	1.3095	.8930 .8834	119	•00(17 •00(14	5.640	458.9	83.421 136.777	1.830	
		1	<u> </u>	L	1		L	L	1	1	L	1	<u> </u>
					PERCE				= 3.57	T		1	1
1.00	60+00 57-14	2696	7354.5	9+102 9+107	1.1774	1.7899	696 693	0-00-44	0.000 .288	559.4	2.159	0.000 .201	49.
1.20	50.00		7246.6	9.121	1.1819	1.6982	686	•00.35	.559	355.5	1.257	.387	96.
1.40	42.86	2570	7161.4	9.136	1.1862	1.6247		•00.28	•763 •905	317.2	1.060	.523 .615	129.
1.60	37.50	2519	7087.6 7033.2	9.148 9.156	1.1901	1.5642		*00.23 *00.19	1.000	707.3	1.000		
2.00	33.93 30.00	2481	6967.6	9.164	1.1972	1.4702	655	•00.14	1.107	308.6	1.010		183.
4.00	1>+00	2167	6622.5	9.199	1.2215	1.2440	609	•00€92	1.600	333.1	1.303	1.018	252.
4.05	14.70	2159	6613.0	9.199	1.2222	1.2389	608	•00(92	1.613	333.9	1.316	1.025	254.
10.00	6.00	1622	6228.5	9.214	1.2498	1.0671		•00t 73	2.141	367.6	2.204	1.263	313.
20.00	000ء د	1561	5974.4	9.216	1.2058	1.0282		+00(63	2.529	389.3 407.3	3.454 5.529		346.
40.00	1.50	1362	5754.8	9.216	1.2806	.9643	431	•00:54	2,916	407.63	3,329	1.500	3,3.
100.00	•60	1109	5511.3		1.3004	.9335		•00(43	3.444		10.479		400+
200.00	•30	796	5358.4	9.216	1.3148	•9005 •8733	309 262	•00(36 •00(30	3.867	438.0	17.107 28.011	1.682	416.
400+00	-15	(46	3220.8	7.210	1.3218	.0133	202		1	İ	_	1	
1000.00	•06	632	5080.3	9.216	1.3415	.8469	208	+00-23	4.979	457.4	53.887	1.792	444.
2000.00 4000.00	•03 •02	529	5001.7 4929.4	9.216 9.216	1.3500	.8317 .8212		•00(19 •00(16		463.4	88.516 145.512	1.854	459.
		1	<u>i</u>	1	DENCE	L		<u>. </u>	L	J	L	L	
						,	,	12, C/F	,			T 0= 000	
1.00	60.00 57.14	2828	6769.6	9.811	1.1605	2.0170	728	0.00.65 .00.63	0.000	552.0	2.147	0.000	49.
1.05	50.00	2765	6666.5	9.839	1.1636	1.9138	719	•00.56	.563	351.2	1.251	.385	94.
1.40	42.86	2711	6581.4	9.861	1.1667	1.8287	711	+00.48	•769		1.057		128.
1.60	37.50	2664	6509.1	9.879 9.890	1.1695	1.7571	704 699	•00 41 •00 37	1.000		1.008	.612	150.
2.00	34.19 30.00	2632	6459.9	9.906	1.1750	1.6426	692	•00.31	1.114	305.8	1.012	.738	181.
4-00	15.00	2335	6050.4	9.969	1.1964	1.3401	651	•00 03	1.607	331.1	1.317	1.017	250
4+08	14.70	2327	6040.9	9.970	1.1971	1.3326	650	+00 03	1.620	332.0	1.331	1 1.024	251
10.00	6.00	1996	5655.8	10.006	1.2285	1.0939	>88	•00: 79	2.139	366.7	2.252		311.
20.00	3.00	1748	5398.4	10-014	1.2401	1.0036	535	•00 67	2.517	389.1	3.552	1.405	345
40.00	1.50	1518	5174.1	10.016	1.2634	.9523	479	•00.58	2.896	407.8	5.719	1.515	372.
100.00	•60	1247	4923.4	10.016	1.2027	.9003	406	■00-47	3.411		10.920	1.630	400
200.00	•30	1067	4764.5	10.016	1.2976	.8050	352	+00 39	5.821	439.7	17.932	1.698	417
400.00	•15	907	4629.0	10.016	1.3118	.8347	304	•00-33	4.258	449.7	29.520	1.755	431.
1-00-00	.06	727	4481.0	10.016	1.3285	.8023	242	•00 25	4.889		57.146		446.
													455.
1000.00 2000.00	-03	512	4389.2	10.016	1.3383	.7848		•00 21 •00 17	5.418		94.228	1.851	462

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(a) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio, P./P	Static pressure, P, lb/sg in.	Temp- erature, T,	Enthalpy, h,	Molecular weight,		Specific heat, c _{p.}	Viscos- ity, μ,	conductivity,	M	Specific impulse in vacuum I vac	Area ratio,	Thrust coefficient C _f	I,
	obs	°K			γ	cal/(g)(°K)	poises	cal/(sec)(°K)(cm	<u> </u>	(lb)(sec)/lb	Ε	٠,	ilbi(sec)/ilb
			F	- 0.600	PERCE	ENT FUEL	= 17.	35. O/F	= 4.76	2			
1.00	60.00	3015	5841.6	11.142	1.1386	2.5641	111	0.00216	0.000	1	T	0.000	0.0
1.05	57.14	3001	5615.4	11.154	1.1389	2.5343	175	-00∠14	.293	232.2		.199	47.7
1.20	50+00 42+86	2961	5744.6 5664.3	11.186	1.1407	2.4522		•00206 •00197	+269	341.0	1.244	.382	91.9
1.60	37.50		5596.0	11.251	1.1419	2.2736	757	*00197	.921	305.0	1.054	•609	124.2
1.74	34.55	2849	5554.5	11.269	1.1527	4.2225	753	.00104	1.000	296.4	. 1.000	.658	158.0
2.00 4.00	30.00 15.00			11.429	1.1442	2.1350	747	•00176		298.1 324.5	1.014	.734	176.3
4.08	14.70			11.429	1.1555	1.7099	714	•00439 •00138		325.4	1.339	1.016	244-1
20.00	6.00 3.00	2299	4768.9 4509.2	11.547	1.1811	1.2736	665 620	•00099 •00079	2.143	361.9	3.762	1.272	305.5
40.00	1.50	1825	4278.5	11.010	1.2290	.9310		•00065	2.054	400.6	6.136	1.535	368.8
100.00	•60	1529	4016.0	,, ,,,	1 1-01								300
200.00	•30	1326	3846.9	11.616	1.2005	.8551 .8176	496	•00053 •00045	3.341	427+1 440+3	11.885	1.659	398.6 416.6
400.00	•15	1144	3700.6	11.616	1.2790	.7842	385	96000			34.844	1.197	431.6
1000.00	•06	932	3538.3	11.016	1.2981	.7449	317	+00030	4.719	463.2	64.475	1.864	447.7
2000.00	•03	792		11.616	1.3116	-7401	269	•00025	5.202			1.904	
4000.00	+02	670		11.616	1.3234	•7001	226	+00021	5.730	476.4			
				= 0-700	. DERCE	NT FUEL	· 15-1	25. O/F	- 5-554		L		
		r				· ·					,		
1.00	60.00		5138.3	12.360	1.1266	3.1609	811	0.00273	0.000		l i	0.000	0.0
1.05	57.14 50.00		5113.8 5047.5	12.375 12.417	1.1206	3.1356 3.0646	804 804	•00270 •00262	.572	517.7 530.1 295.5	2.122	.19E	46.1 88.9
1.40	42.86	3037	4972.3	12.464	1.1264	2.9793	798	•00252	.780	295.5	1.051	.515	120.2
1.60	37.50		4908.1	12.504	1.1265	2.9028	790	•00246	.926	200.2	1.005	.607	141.5
2.00	34.75	2981 2943	4871.9 4803.0	12.527	1.1266	2.7698	790 784	•00241 •0023	1.000 1.131	287.4 289.3	1.000	•652 •732	152.2
4.00	15.00	2761		12.762	1.1301	2.3262	750	•00191	1.650	315.9	1.015	1.016	237.0
4.08	14.70	2756	4484.0	12.767	1.1303	2.3126	757	*00140		316.8	1.369	1.022	
10.00	6.00	25171	4119.3	12.975	1 10 11	3 7 1110	719		. 161		3 (3)		107.0
20.00	00 و د	2320	3863.7		1.1599	1.7290	685	•00138 •00105	2.498	354.1 379.0	2.414 3.943	1.4276	297.8 333.0
40.00	1.50	2108		13.168	1.1847	1.0559	644	•00080		400.3	6.551		362.1
100.00	•60	1813	2240.7	13 304	3 21.72	•85 8 3	579		3.272				
200.00	• 90	1596	3360.7 3183.1	13.208	1.2172		2/2	+00061 +00052	3.272	423.5 437.8	12.932	1.685	393.3
400.00	• 15	1395	3027.4	13.216	1.2487	.7553	470	•00044	4.015	444.4	36.494	1.857	428.6
1000.00	•0•	1156	2852.1	13.216	1.20/0	.7136	97د	•00036	4.257		72.66n	1.911	
2000.00	•03	996	4740.1	13.216	1.2014	-6048	344	•00036			122.229	1.711	446.0
4000.00	•02	853	2643.9	13.216	1.2702	.6>96	294			477.9	205.254	1.996	465.9
			R	= 0.800	• PERCE	NT FIJEL	 z 19.6		= 6•349				
										,	,		
1.00	60.00 57.14			13.470		3.6135 3.5978	835 688	0.00317	0.000	500.7	2.117	0.000 197	0•0 44•6
1.20	50.00	3141	4502.0	13.536	1.1199	3.5527	828	00309		319.4	1.238	380	86.0
1.40	42.86	3103	4431.5	13.593	1.1193	3.4973.	823	30د00•	.782	∠86.0	1.050	-514	116.3
1.60	37.50			13.641	1.1168	3.4461	618	•00297		279.0		•606	137.0
2.00	34.85	3016	4272.7		1.1106	3.4169	615 016	•00293 •00286	1.134	278.3	1.000	.650 .731	147.0
4.00	15.00	2853	3980.7		1.1170	1.0101	786	•00251	1.635		1.361	1.015	229.7
4.08	14.70	2848	3972.4	13.968	1.1170	3.0070	785	•00450	1.648	201.5	1.376	1.024	231.2
10.00	6.00	2645	3625.9	14.254	1.1190	4.4611	754	•00199	c+158	344.6	2.455	1.278	289.2
20.00	3.00	2487	3379.6	14.450	1.1252	1.9610	727	+00199 +00157 +00117	2.205	370.0	4.060	1.433	324.1
40.00	1.50	2321	3151.6	14.611	1.1306	1.5064	698	•00117	2.026	392.2	6.873	1.562	353.4
100.00	•60	2074	2878.8	14.750	1.1705	1.0340	649	•00078	3-232	417.1	13.944	1.704	185.5
200.00	.30	1868	2695.0	14,797	1.1982	.8417	604	.00001	3.548	432.6	23.785	1.794	405.7
400.00	.15	1658	2531.0	14.812	1.2191	•7527	うちと	•00051	3.894	445.8	40.475	1.870	122.9
1000.00	.06	1398	2343.4	14.816	1.2303	■6975	479	•00041	4.395	460.3	81.660	1.953	441.8
2000.00	• 03	1220	2221.8	14.516	1.2515	•6676	424	•00035	4.806		138.794	2.006	453.6
4000.00	•02	1058	2116.0	14.816	1.2654	.6395			5.245		235.555	2.050	463.7
		l.	R	= 0.900	PERCE			8, O/F	= 7.143		l	···	
1.00	60.00	Taia T	4142.9	14.479		3 • 75 6 d	854		· · · · · · · · · · · · · · · · · · ·				
1.00	60.00 57.14	3201	4121.5		1.11/9	3.7501	050	0.00335 66600	276	484.9	2,115	0.000	0•0 2•ف
1.20	>0.00	3166	4063.3	14.553	1.11/2	3.7623	842	•00327	274	109.3	1.238	.300	83.2
1.40	42.86		3997.2		1.1103	3.6942	840	•00325	.783	477.1	1.050	•514	112.6
1.60 1.72	37.50 34.69	3044	3940.7 3910.6		1.1157	3.6652	035 668	•00320	1.000	270.3	1.005	•6C5	132-7
2.00	30.00	3047	3848.1		1.1195	3.6481	020		1.136	271.6	1.000	.731	142.2
4.00	15.00	2892	3573.5	15.031	1.1118	3.4127	5O4	•00288	1.637	247.5	1.364	1.015	222.6
4-08	14.70	2888	3565.7	15.039	1.1117	3.4029	504	•002¤7	1.650	∠98.2	1.379	1.022	424.1
10.00	6.00	2701	5238.7	15.377	1.1995	3.0640	774	•00250	2.161	134.6	2.470	1.279	280.5
20.00	3.00	2564	3004.6	15.625	1.1095	2.7328	752	•00217	2.209	359.8	2.470 4.112		314.7
40.00	1.50	2429	2780.4	15.056	1.1113	2.3391	728	•00185	2.832	282.1	7.032	1.567	343.6
100.00	•60	2246	2520.2	16.124	1.1212	1.7259	695	1 د 001	3.234	407.8	14.621	1.714	375.6
200+00	•30	2095	2332.5	16.278	1-1403	1.2476	004	•00093	3.021	424.6	25.591	1.655	346.€
400+00	•15	1912	2160.1	16.370	1.1721	.0700	025	•00000	3.605	437.2	44.562	1.592	414.7
1000.00	•06	1660	1967.2	16.410	1.2081	.7114	260	-00348	4.233	455.2		1.985	435.1
2000.00	.03	1468	1836.1	16.415	1.2238	1600.	207	+00041	4.606	465.3	157.405	4.044	448 . C
+000+00	• 0 2	1289.	1720.5	16-416	1.2307	•6325	454	•00035	5.010	473.9	269.819	2.094	459.1

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID (XYGEN

(a) Continued. Combustion-chamber pressure, 60 pourds per square inch absolute; equilibrium composition during isentropic expansion

ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, #,	Thermal conductivity,	Mach number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	Specific impulse, I,
P./P	lb∕sqin. oxbs	°K	cal/g	900	γ	col/(g)('K)'	micro poises	col/(sec): 'K)(cm)	•	I voc. (lb)(sec)/lb	E	C,	(lb)(sec)/(l
			F	1.00) PERCE	NT FUEL	= 11•	19. O/F	= 7.93	7			
1.00	60.00	3217	3777.9	15.399	1.1174	3.6327	864	0.0(328	0.000	1		0.000	0 • 0
1.05	57.14	3205	3757.7	15.420	1.1171	3.6262	862	•0(327	•296	470.6	2.115	.197	41.9
1.20	50.00	3173	3702.9	15.478	1.1153	3.6075	654	•0(323	•574 •784	300 • 2 268 • 9	1.237	.380	80+8
1.40	42.86 37.50	3136	3587.4	12.602	1.1147	3.5018	047	•0(319 •0(315	.750	262.4	1.050	•514 •605	109 • 3
1.72	34.91	3048	3559.2	15.633	1.1143	3.5493	645	•0(313	1.000	261.7	1.000	•648	137.9
2.00	30.00 15.00	3053 2900	3500.2 3241.5	15.698	1.1136	3.5214	840 816	•00309 •00288	1.136	263.6 288.6	1.017	1.015	155•4 216•0
4.00	14.70	2896	3234.1	15.998	1.1103	3.3631			1.650	289.5	1.380	1.022	217.5
10.00	6.00	2713	2925.7	16.363	1.1074	3+1047	786	•00256	2.161	324.9	2.474	1.280	272.3
20.00 40.00	3.00 1.50	2579 2452	2704.9	16.634	1.1060	2.8627	764 742	•00230 •00203	2.509	349.4 371.3	4+124 7+068	1.436	305 • 6
		_	-					i			-		
200.00	•60 •30	2287	2245.2	17.431	1.1075	2.1650	711	•00166 •00138	3.237	396.6 413.5	14.785 26.152	1.716	365 • 2 385 • 7
400.00	•15	2037	1903.2	17.624	1.1167	1.5363	000	.00111	3.820	428.6	46.510	1.898	403.5
1000.00	•00	1859	1703.0	17.026	1.1309	1.1590	617	•00079	4.197	446.1	99.697	1.997	424.5
2000.00	• 03	1710	1565.5	17.928	1.1594	.8914	281	•00000	4.487	457.6	176.636	2.062	438.8
4000.00	•02	1549	1440.4	17.985	1.1009	.7318	537	•00047	4.798	467.5	310.311	2.119	451.0
			R	= 1.500	PERCE	NT FUEL	= 7.7	49. J/F	=11.905	5			
1.00	60.00	3116	2626.1	18.987	1.1200	2.2973	889	0.00216	0.000			0.000	0.0
1.05	57.14	3103	2610.2	19.010	1.1198	2.2869	887	-00214	•296	417.0	2.117	.197	37.2
1.20	50.00 42.86	3070	2567.2	19.074	1.1193	2.2574	881 875	•00500 •00510	•574 •783	266.0 238.2	1.238	•380 •514	71.6
1.00	37.50	2999	2476.6	19.210	1.1183	2.1892	869	•00202	.928	232.4	1.005	605	114.1
1.72	34.00	2981 2940	2454.0	19.244	1.1101	2.1710	867 861	•0(199 •0(195	1.000	231.8 233.4	1.000	.650	122.4
2.00 4.00	30+00 15+00	2782	2400.2	17.623	1.1167	1.9340	033	.00172	1.635	255.4	1.361	1.015	191.3
4.00	14.70	2777	2199.9	19.632	1.1167	1.9277	832	•0¢171	1.648	256.1	1.377	1.022	192.6
10.00	6.00	2576	1959.5	19.999	1.1103	1.6500	796	•0(140	2.158	287.1	2.454	1.278	240.8
20.00	3.00	2421	1788.5	20+250	1.1227	1.3799	767	•00115	2.506	308.3	4.065	1.433	270 • 0
40.00	1.50	2263	1630.0	20.463	1.1317	1.1285	736	•00 192	2.830	326.9	6.896	1.563	294.4
100.00	•60	2040	1439.4	20.667	1.1538	-8344	586	•00066	3.238	347.9	14.098	1.706	321.3
200.00 400.00	•30 •15	1856	1309.6	20.755	1.1784	.6739 .5774	595	•00051 •00041	3.545	361.3 372.7	24.259 41.606	1.796	338.4 353.1
													_
2000.00	•06	1415	970.6	20.610 20.612	1.2423	.5156 .4070	524 467	•00 333 •00 349	4.745	385.2	144.082	2.015	369.3 379.5
4000.00	• 02	1000	093.9	د 10٠٥١٤	1.2556	•4670	416	•00324	5.173	399.8			388.2
1	1	1	. ا	2.000	PERCE	NT FUEL	= 5.0		: =15•873				
· _T	,					,						I	
1.00	60.00 57.14	2955	2016.0	21.453	1.1264	1.5209	886 884	0.0C145 .0C144	0.000	382.7	2,122	0+000 •198	0 • 0 34 • 1
1.20	>0.00		1966.4	21.537	1.1264	1.4788	676	+0C140	.572	244.0	1.240		
1.40	42.80			21.606								.381	65.7
1.60		2877	1925.3		1.1265	1.4419	870	•0C135	•780	218.4	1.052	.381 .515	65.7 88.8
1.73	37.50	2841	1890.2	21.665	1.1267	1.4091	864	•00135 •00132	.926	213.0	1.052 1.005	.381 .515 .607	65.7 88.8 104.6
1.73	37.50 34.75 30.00	2841 2821 2783	1890+2 1870+4 1832+8	21.665 21.698 21.761	1.1267 1.1268 1.1272	1.4091 1.3901 1.3529	864 861 854	.00135 .00132 .00129 .00125	.926 1.000 1.131	213.0 212.4 213.8	1.052 1.005 1.000 1.015	.381 .515 .607 .653	65.7 88.8 104.6 112.6 126.3
2 • 0 0 4 • 0 0	37.50 34.75 30.00 15.00	2841 2821 2783 2604	1890.2 1870.4 1832.8 1663.4	21.665 21.698 21.761 22.035	1.1267 1.1268 1.1272 1.1309	1.4091 1.3901 1.3529 1.1688	864 861 854 821	.00135 .00132 .00125	.926 1.000 1.131 1.630	213.0 212.4 213.8 233.5	1.052 1.005 1.000 1.015 1.353	.381 .515 .607 .653 .732	65.7 88.8 104.6 112.6 126.3 175.2
2.00	37.50 34.75 30.00 15.00 14.70	2841 2821 2783 2604 2999	1890.2 1870.4 1832.8 1665.4 1658.6	21.665 21.698 21.761 22.035 22.043	1.1267 1.1268 1.1272 1.1309 1.1310	1.4091 1.3901 1.3529 1.1688 1.1652	864 861 854 821 820	*00135 *00132 *00129 *00125 *00105	.926 1.000 1.131 1.630 1.642	213.0 212.4 213.8 233.5 234.2	1:052 1:005 1:000 1:015 1:353 1:368	.381 .515 .607 .653 .732 1.016 1.022	65.7 88.8 104.6 112.6 126.3 175.2 176.4
2.00 4.00 4.00	37.50 34.75 30.00 15.00 14.70	2841 2821 2783 2604 2977	1890.2 1870.4 1632.8 1663.4 1658.6	21.665 21.698 21.761 22.035 22.043	1.1267 1.1268 1.1272 1.1309 1.1310	1.4091 1.3901 1.3529 1.1666 1.1652	864 861 854 821 820	.00135 .00132 .00129 .00125 .00105	.926 1.000 1.131 1.630 1.642 2.152	213.0 212.4 213.8 233.5 234.2	1.052 1.005 1.000 1.015 1.353 1.368	.381 .515 .607 .653 .792 1.016 1.022	65.7 88.8 104.6 112.6 126.3 175.2 176.4
2.00 4.00 4.00	37.50 34.75 30.00 15.00 14.70	2841 2821 2783 2604 2999	1890.2 1870.4 1832.8 1665.4 1658.6	21.665 21.698 21.761 22.035 22.043	1.1267 1.1268 1.1272 1.1309 1.1310	1.4091 1.3901 1.3529 1.1688 1.1652	864 861 854 821 820	*00135 *00132 *00129 *00125 *00105	.926 1.000 1.131 1.630 1.642	213.0 212.4 213.8 233.5 234.2	1:052 1:005 1:000 1:015 1:353 1:368	.381 .515 .607 .653 .732 1.016 1.022	65.7 88.8 104.6 112.6 126.3 175.2 176.4
2.00 4.00 4.03 10.00 20.00 40.00	37.50 34.75 30.00 15.00 14.70 5.00 3.00 1.50	2841 2821 2783 2604 2277 2365 2177 1978	1890.2 1870.4 1632.8 1663.4 1658.6 1459.5 1319.9	21.665 21.698 21.761 22.035 22.043 22.333 22.496 22.600	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1265 1.1608	1.4091 1.3901 1.3529 1.1660 1.1652 .9205 .7501 .6166	864 861 854 821 820 774 734 689	.00135 .00132 .00125 .00125 .00105 .00105	.926 1.000 1.131 1.630 1.642 2.152 2.200 2.831	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9	1.052 1.005 1.005 1.015 1.353 1.368 2.412 3.941 6.557	.381 .515 .607 .653 .732 1.016 1.022	65.7 88.8 104.6 112.6 126.3 175.2 176.4 220.1 246.1 267.6
2.00 4.00 4.08 10.00 20.00	37.50 34.75 30.00 15.00 14.70 6.00 3.00 1.50	2841 2821 2783 2604 2277 2365 2177 1978	1890.2 1870.4 1832.8 1663.4 1658.6 1459.5 1319.9	21.665 21.698 21.761 22.035 22.043 22.333 22.496	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1365	1.4091 1.3901 1.3529 1.1660 1.1652 .9200 .7501 .6166 .5100 .4699	864 861 854 821 820 774 734 689 621 566	.00135 .00132 .00129 .00125 .00105 .00105	.926 1.000 1.131 1.630 1.642 2.152 2.200	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 0.557	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552	65.7 88.8 104.6 112.6 126.3 175.2 176.4 220.1 246.1 267.6 290.7
2.00 4.00 4.08 10.00 20.00 40.00	37.50 34.75 30.00 15.00 14.70 6.00 3.00 1.50	2841 2821 2783 2604 2277 2365 2177 1978	1890-2 1870-4 1632-8 1663-4 1658-6 1459-5 1319-9 1392-9	21.665 21.698 21.761 22.035 22.043 22.333 22.496 22.600	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1565 1.1608	1.4091 1.3901 1.3529 1.1688 1.1652 -9205 -7501 -6166	864 861 854 821 820 774 734 689	+0C135 +0C132 +0C125 +0C105 +0C105 +0C105 +0C105 +0C163 +0C150	.926 1.000 1.131 1.630 1.642 2.152 2.200 2.831	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 0.557	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552	65.7 88.8 104.6 112.6 126.3 175.2 176.4 220.1 246.1 267.6
2.00 4.00 4.08 10.00 20.00 40.00	37.50 34.75 30.00 15.00 14.70 6.00 3.00 1.50	2841 2821 2783 2604 2599 2365 2177 1978 1706 1505	1890-2 1870-4 1832-8 1663-4 1658-6 1459-5 1319-9 1192-9	21.665 21.698 21.761 22.033 22.043 22.496 22.600 22.660 22.673	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1565 1.1608 1.2122 1.2306	1.4091 1.3901 1.3529 1.1660 1.1652 .9200 .7501 .6166 .5100 .4699	864 861 854 821 820 774 734 689 621 566	.00135 .00132 .00125 .00125 .00105 .00105 .00363 .00363	.926 1.000 1.131 1.630 1.642 2.152 2.200 2.831 3.273 3.629	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 0.557	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552	65.7 88.8 104.6 112.6 126.3 175.2 176.4 220.1 246.1 267.6 290.7
2.00 4.00 4.00 10.00 20.00 40.00 100.00 400.00 1000.00 2000.00	37.50 34.75 30.00 12.00 14.70 5.00 3.00 1.50 .60 .30 .15	2841 2821 2783 2604 2979 2365 2177 1978 1706 1505 1318 1095 945	1890.2 1870.4 1832.8 1653.4 1658.6 1459.5 1319.9 1192.9 1044.7 947.2 861.6 764.9 703.1	21.665 21.698 21.761 22.035 22.043 22.933 22.496 22.600 22.660 22.677 22.677	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1365 1.1608 1.2122 1.2306 1.2490 1.2620 1.2749	1.4091 1.3901 1.3529 1.1686 1.1652 -9205 -7501 -6106 -5100 -4699 -4457 -4221 -4064	864 861 854 821 820 774 734 689 621 566 510	+0C135 +0C132 +0C129 +0C125 +0C105 +0C105 +0C333 +0C333 +0C333 +0C324 +0C323	.926 1.900 1.131 1.630 1.642 2.152 2.900 2.831 3.273 3.629 4.008	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.6 348.7	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838	65.7 88.8 104.6 112.6 112.6 112.6 175.2 176.4 220.1 246.1 246.1 290.7 305.0 316.9 329.9 338.0
2.00 4.00 4.00 10.00 20.00 40.00 100.00 200.00 400.00	37.50 34.75 30.00 15.00 14.70 5.00 3.00 1.50 60 .30 .15	2841 2821 2783 2604 2277 2365 2177 1978 1706 1505 1318	1890.2 1870.4 1832.8 1663.4 1658.6 1459.5 1319.9 1192.9 1044.7 947.2 861.6 764.9 703.1 649.8	21.665 21.698 21.761 22.035 22.043 22.496 22.600 22.667 22.677 22.677 22.677	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1505 1.1608 1.2122 1.2306 1.2420 1.2620 1.2749 1.2062	1.4091 1.3901 1.3529 1.1666 1.1652 .9205 .7701 .6166 .5100 .4699 .4457 .4221 .4064 .3916	864 861 854 820 774 734 689 621 566 510 438 386 337	+ OC 135 + OC 132 + OC 125 + OC 125 + OC 105 + O	.926 1.000 1.131 1.630 1.642 2.152 2.200 2.831 3.273 3.629 4.008 4.546 4.986 5.460	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.6 348.7 353.8	1.052 1.005 1.000 1.015 1.353 1.358 2.4412 3.941 0.557 12.980 21.822 36.754 73.335	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838	65.7 88.8 104.6 112.6 112.6 126.3 175.2 175.4 220.1 246.1 267.6 290.7 305.0 316.9
2.00 4.00 4.00 10.00 20.00 40.00 100.00 400.00 1000.00 2000.00	37.50 34.75 30.00 12.00 14.70 5.00 3.00 1.50 .60 .30 .15	2841 2821 2783 2604 2979 2365 2177 1978 1706 1505 1318 1095 945	1890.2 1870.4 1832.8 1663.4 1658.6 1459.5 1319.9 1192.9 1044.7 947.2 861.6 764.9 703.1 649.8	21.665 21.698 21.761 22.035 22.043 22.496 22.600 22.667 22.677 22.677 22.677	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1505 1.1608 1.2122 1.2306 1.2420 1.2620 1.2749 1.2062	1.4091 1.3901 1.3529 1.1666 1.1652 .9205 .7701 .6166 .5100 .4699 .4457 .4221 .4064 .3916	864 861 854 820 774 734 689 621 566 510 438 386 337	+0C135 +0C132 +0C129 +0C125 +0C105 +0C105 +0C333 +0C333 +0C333 +0C324 +0C323	.926 1.000 1.131 1.630 1.642 2.152 2.200 2.831 3.273 3.629 4.008 4.546 4.986 5.460	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.6 348.7 353.8	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838	65.7 88.8 104.6 112.6 112.6 112.6 175.2 176.4 220.1 246.1 246.1 290.7 305.0 316.9 329.9 338.0
2.00 4.00 4.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00	37.50 34.75 30.00 15.00 14.70 6.00 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1	2841 2821 2783 2604 2999 2365 2177 1978 1706 1505 1318 1095 945 812	1870-2 1870-4 1852-8 1653-4 1658-6 1459-9 1319-9 1272-9 1044-7 947-2 861-6 764-9 R	21.665 21.665 21.761 22.035 22.043 22.4946 22.6673 22.677 22.677 22.677 22.677	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1309 1.1608 1.2122 1.2306 1.2420 1.2749 1.2062 , PEKCE	1.4091 1.3929 1.1588 1.1688 1.1689 .7201 .6166 .5100 .4699 .4457 .4221 .4064 .3916	864 861 821 820 774 734 689 621 566 510 438 386 337	.0C135 .0C132 .0C129 .0C109 .0C109 .0C109 .0C009 .0C009 .0C009 .0C038 .0C033 .0C033 .0C030 .0C033 .0	.926 1.000 1.131 1.630 1.642 2.152 2.200 3.273 3.629 4.008 4.546 4.986 5.460	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.6 348.7 353.8	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838 1.913 1.960 1.999	65.7 88.8 104.6 112.6 112.6 175.2 176.4 220.1 246.1 246.1 257.6 316.9 329.9 338.0 344.8
2.00 4.00 4.00 10.00 20.00 +0.00 100.00 200.00 400.00 1000.00 400.00	37-50 34-75 30-00 15-00 14-70 6-00 3-00 1-50 -30 -30 -30 -30 -30 -03 -02	2841 2821 2783 2604 2977 2365 2177 1978 1706 1505 1318 1095 812	1890.2 1870.4 1822.8 1653.4 1653.6 1459.5 1319.9 1172.9 1044.7 747.2 801.6 764.9 703.1 649.8	21.665 21.665 21.761 22.035 22.043 22.404 22.660 22.673 22.677 22.677 22.677 22.677 22.677 22.677 22.677	1-1267 1-1268 1-1272 1-1309 1-1310 1-1424 1-1069 1-2122 1-2309 1-2490 1-2749 1-2062 , PERCE	1.4091 1.3901 1.3529 1.1652 1.1652 .9209 .7701 .6166 .5100 .4659 .4457 .4221 .4064 .3916 .8048	864 861 824 820 774 734 689 621 566 510 438 386 337 = 4.0	.0C135 .0C132 .0C129 .0C129 .0C107 .0C107 .0C108 .0C38 .0C38 .0C33 .0C38 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33 .0C33	.926 1.000 1.131 1.630 1.642 2.152 2.200 2.831 3.273 3.629 4.008 4.546 4.986 5.460	213.0 212.4 213.8 233.5 234.2 261.7 290.9 313.1 323.8 332.8 342.6 348.7 353.8	1.052 1.005 1.005 1.353 1.358 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .515 .607 .553 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838 1.913 1.990	65.7 88.8 104.6 112.6 112.6 112.6 175.2 176.4 220.1 246.1 246.1 246.1 290.7 305.0 316.9 329.9 338.0 344.8
2.00 4.00 4.00 10.00 20.00 40.00 200.00 400.00 100.00 200.00 400.00 1.00 1.00 1.00	37.50 34.72 30.00 12.00 14.70 6.00 3.00 1.20 60.00 0.3 .02	2841 2821 2783 2604 2777 2367 1776 1706 1505 1318 1095 945 812	1890.2 1870.4 1870.4 1870.4 1870.4 1870.2 1919.9 1192.9 1192.9 1044.7 747.2 801.6 764.9 703.1 649.8 R	21.665 21.761 22.039 22.496 22.496 22.6673 22.6677 22.677 22.677 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1305 1.2122 1.2306 1.2420 1.2420 1.2506 1.27420 1.2062 1.2742 1.1303 1.1310 1.1310 1.1310	1.4091 1.3901 1.3529 1.1008 1.1052 -9209 -7201 -6166 -5100 -4659 -4457 -4221 -4064 -3916 NT FUEL 0.8140 -8048 -7795	864 861 821 820 774 734 689 621 510 438 5337 \$40 848 848 848	.0C135 .0C132 .0C102 .0C103 .0C103 .0C103 .0C103 .0C330 .0C330 .0C330 .0C33 .0	.926 1.000 1.131 1.630 1.642 2.152 2.2000 2.831 3.629 4.008 4.546 4.986 5.460	213.0 212.4 213.8 233.5 234.2 260.1 290.9 313.1 323.8 332.8 342.6 348.7 353.8	1.052 1.005 1.000 1.015 1.353 1.358 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .51b .607 .553 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838 1.999	65.7 88.8 104.6 112.6 126.3 175.2 176.4 220.1 246.1 24
2.00 4.00 4.00 20.00 20.00 20.00 200.00 200.00 400.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00	37-50 34-72 30-00 15-00 14-70 5-00 3-00 1-20 -60 -30 -12 -05 -03 -03 -02	2841 2821 2783 2604 2777 2365 2177 1776 1706 1500 1318 1095 945 812 2650 2640 2597 2500 2507	1890.2 1870.4 1832.8 1653.4 1653.4 1654.5 1319.9 1044.7 747.2 861.6 764.9 703.1 649.8 R 1381.4 1370.9 1342.7 1310.6 1283.4	21.665 21.676 21.761 22.093 22.043 22.660 22.667 22.677 24.598	1-1267 1-1268 1-1272 1-1309 1-1424 1-1305 1-1008 1-2122 1-2306 1-2420 1-2240 1-2262 , PERCE 1-1003 1-1210 1-1229 1-1229 1-1229	1.4091 1.3901 1.3929 1.1062 1.1062 1.9209 1.7001 1.106 1.106 1.106 1.106 1.107	864 861 821 820 774 734 689 621 566 510 438 337 = 4.0	.0C135 .0C132 .0C102 .0C102 .0C103 .0C103 .0C103 .0C003 .0	926 1.000 1.131 1.650 1.642 2.152 2.831 3.273 3.629 4.008 4.546 4.986 5.460 0.000 .722 .566 .772	213.0 212.4 213.8 233.5 234.2 260.1 295.9 313.1 323.8 332.8 332.8 342.6 348.7 353.8	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 0.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .51b .607 .553 .732 1.016 1.022 1.276 1.427 1.552 1.768 1.768 1.989 1.999	65.7 88.8 104.6 112.6 112.6 112.6 112.6 12.6 12.6 12.
2.00 4.00 4.00 10.00 20.00 100.00 200.00 400.00 1000.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00	37.50 34.72 30.00 12.00 12.00 44.70 6.00 3.00 1.20 60.00 9.02	2841 2821 2783 2604 2777 2367 1776 1706 1505 1318 1095 945 812	1890.2 1870.4 1892.8 1693.6 1693.6 1497.9 1917.9 1044.7 747.2 861.6 764.9 703.9 1381.4 1370.9 1381.4 1370.9 1342.7 1310.6 1283.4 1265.7 1239.8	21.665 21.761 22.039 22.496 22.496 22.6673 22.6677 22.677 22.677 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532 24.532	1.1267 1.1268 1.1272 1.1309 1.1310 1.1424 1.1305 1.2122 1.2306 1.2420 1.2420 1.2506 1.27420 1.2062 1.2742 1.1303 1.1310 1.1310 1.1310	1.4091 1.3901 1.3929 1.1062 1.1052 1.9209 1.7701 1.106 1.106 1.107	864 861 821 820 774 734 689 621 510 438 5337 \$40 848 848 848	.0C135 .0C132 .0C102 .0C103 .0C103 .0C103 .0C103 .0C330 .0C330 .0C330 .0C33 .0	.926 1.000 1.131 1.630 1.642 2.152 2.2000 2.831 3.629 4.008 4.546 4.986 5.460	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.7 353.8 213.4 215.4 192.5 186.9 187.9	1.052 1.005 1.000 1.015 1.353 1.358 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .51b .607 .553 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838 1.999	65.7 88.8 104.6 1126.3 175.2 175.4 220.1 246.1 2
2.00 4.00 4.00 10.00 20.00 100.00 200.00 400.00 1000.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00 1.	37-50 34-72 30-00 12-00 12-00 3-00 1-70 -60 -30 -12 -00 -02 -00 -02 -02 -00 -02 -00 -02 -00 -00	2841 2821 2783 2604 2347 2177 1978 1706 1503 1318 1095 945 812 2600 2640 2594 2500 2500 2481 2438 2218	1890.2 1870.4 1832.8 1003.0 1003.0 1459.0 1319.9 1319.9 1472.2 801.6 764.9 703.1 649.8 1381.4 1370.9 1342.7 1310.0 1283.4 1253.7 1239.0 1109.8	21.665 21.678 21.161 22.033 22.043 22.600 22.660 22.677 22.677 22.677 22.677 22.677 24.532 24.548 24.548 24.548 24.548 24.548 24.548 24.548	1-1267 1-1268 1-1272 1-1390 1-1390 1-1390 1-1408 1-2122 1-2306 1-2490 1-2520 1-2520 1-2520 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594 1-1594	1.4091 1.3901 1.3901 1.1032 1.	### ### ### ### ### ### ### ### ### ##	.0C135 .0C132 .0C102 .0C103 .0	-926 1.000 1.131 1.640 2.152 2.200 2.831 3.273 3.629 4.008 4.5460 -23.81c	213.0 212.4 213.8 233.5 234.2 261.7 280.1 275.9 313.1 323.8 342.6 342.6 348.7 353.8 187.5 187.5 187.5 187.5	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163 2.162 2.16	.381 .515 .607 .653 .732 1.016 1.022 1.276 1.447 1.552 1.685 1.788 1.999 0.000 .1999 0.000 .1999 384 .519 .661 .661	65.7 88.8 104.6 1126.3 175.2 176.4 220.1 246.1 2
2.00 4.00 4.00 2.00 4.00 100.00 200.00 100.00 200.00 400.00 100.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00 1.	37.50 34.72 30.00 15.00 14.70 6.00 3.00 1.50 60.00 .03 .02 60.00 .7.14 20.00 42.88 37.50 34.33	2841 2821 2783 2604 2777 2367 2177 1776 1706 1505 1318 1095 945 812 2650 2690 2590 2590 2590 2590 2438	1890.2 1870.4 1892.8 1693.6 1693.6 1497.9 1917.9 1044.7 747.2 861.6 764.9 703.9 1381.4 1370.9 1381.4 1370.9 1342.7 1310.6 1283.4 1265.7 1239.8	21.665 21.6761 22.073 22.073 22.673 22.673 22.677 22.677 22.677 22.677 22.677 22.677 22.677 24.072 24.030 25.030 26.030 26.030 26.030 26.030 26.030 26.030 26.030 26.030 26.030 26.030 26.03	1-1267 1-1268 1-1272 1-1309 1-1309 1-1408 1-2122 1-2306 1-2429 1-2249 1-2262 , PERCE 1-1503 1-1510 1-1510 1-1510 1-1510 1-1510	1.4091 1.3901 1.3929 1.1062 1.1052 1.9209 1.7701 1.106 1.106 1.107	# 4.0 774 734 521 520 774 734 526 510 438 5337 # 4.0 # 548 # 548	.0C135 .0C132 .0C102 .0C102 .0C103 .0	.926 1.000 1.131 1.640 1.642 2.152 2.831 3.273 3.629 4.008 4.546 4.986 5.460 0.000 .292 .566 .772 .915	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.7 353.8 213.4 215.4 192.5 186.9 187.9	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.491 6.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .51b .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.938 1.913 1.999 0.000 1.999 .384 .519 .519 .664	65.7 88.8 104.6 1126.3 175.2 175.4 220.1 246.1 2
2.00 4.00 4.00 2.00 2.00 2.00 2.00 2.00	37.50 34.72 30.00 15.00 14.70 6.00 3.00 1.00 .00 .00 .00 .00 .00 .00	2841 2821 2783 2604 2077 1978 1700 1500 1318 1095 945 812 2600 2509 2509 2509 2438 2216 2209 1915	1890.2 1870.4 1832.8 1603.4 1603.6 1459.5 1319.9 1319.9 1044.7 747.2 801.6 649.8 R 1381.4 1370.9 1342.7 1310.6 1283.4 1265.7 1299.8 1109.8 1109.8	21.665 21.678 21.761 24.033 24.95 24.600 22.660 22.673 24.677 24.677 24.677 24.547 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.676 24.677	1-1267 1-1268 1-1272 1-1309 1-1310 1-1424 1-1309 1-1408 1-2122 1-2306 1-2490 1-2749 1-2582 7 PERCE 1-103 1-1504 1-1504 1-1504 1-1504 1-1604 1-1604 1-1604 1-1604 1-1604	1.4091 1.3901 1.3929 1.1062 1.1062 1.9209 1.7701 1.0106 1.0106 1.0106 1.020 1.	# 4 • C # 5 1 6 9 0 0 6 9 0 0 6 9 0 0 6 9 0 0 6 9 0 0 6 9 0 0 0 0	.0C135 .0C132 .0C129 .0C109 .0C109 .0C109 .0C109 .0C109 .0C109 .0C109 .0C109 .0C133 .0C120 .0C133 .0C120 .0C131 .0C120 .0C131 .0C120 .0C131 .0C120 .0C131 .0C120 .0C131 .0C120 .0C131 .0	.926 1.000 1.191 1.642 2.152 2.900 2.831 3.273 3.629 4.008 4.946 5.460 0.009 2.931 1.000 1.118 1.612 1.625 2.140	213.0 212.4 213.8 233.5 234.2 261.7 280.1 223.8 332.8 342.6 348.7 353.8 348.7 353.8 187.5 187.5 187.5 187.5 187.5 187.5 187.5 187.5 187.5 187.5 187.5 187.5 187.5 203.8 20	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163	.381 .51b .607 .653 .732 1.016 1.022 1.276 1.552 1.685 1.768 1.898 1.913 1.940 0.000 1.999	65.78 88.88 104.66 112.6.32 175.2 2467.6 290.7 290.7 30.2 58.1 100.3 111.3 153.8 191.7
2.00 4.00 10.00 2.000 100.00 200.00 400.00 1000.00 2000.00 400.00 1.00 1.00 1.00 1.00 1.00 1	37.50 34.72 30.00 12.00 14.70 6.00 3.00 1.50 1	2841 2821 2783 2604 2365 2177 1978 1706 1505 1318 1095 812 2655 2640 2599 2438 2216 2209	1890.2 1870.4 1832.8 1653.4 1653.4 1553.6 1319.9 1044.7 747.2 861.6 764.9 703.1 649.8 1381.4 1370.9 1342.7 1310.6 1283.4 1265.7 1219.8 1109.8 1109.8 1109.8 1109.8 1106.2	21.665 21.676 21.761 22.093 22.496 22.660 22.667 22.677 22.677 22.677 22.677 22.677 24.532 24.548	1-1267 1-1268 1-1272 1-1390 1-1390 1-1390 1-1590 1-2420 1-2520 1-2749 1-2522 , PENCE 1-1503 1-1540 1-1524 1-1541 1	1.4091 1.3901 1.3929 1.1062 1.1032 1.7701 1.0100 1.0100 1.4099 1.4457 1.4201 1.4064 1.391b 1.4064 1.7179 1.7200 1.	# # # # # # # # # # # # # # # # # # #	.0C135 .0C132 .0C102 .0C103 .0	-926 1.000 1.131 1.630 1.642 2.152 2.200 2.831 3.629 4.008 4.546 4.946 4.946 4.946 6.946 772 1.1600 1.118 1.612 1.625 2.140 2.5140	213.0 212.4 213.8 233.5 234.2 261.7 280.1 275.9 313.1 323.8 332.8 342.6 348.7 353.8 215.4 192.5 187.5 187.5 187.5 187.9 203.8 204.6	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 728.163 708.163 1.056 1.056 1.000 1.013 1.325 1.339 2.286 3.622	0.000 1.919 0.000 1.929 0.000 1.999 0.000 1.999 0.000 1.999 0.000 1.999 0.000 1.999 0.000 1.999 0.000 1.999	65.7.2.6.8.8.8.8.8.8.8.8.8.8.8.8.8.8.8.8.8.8
2.00 4.00 4.00 2.00 2.00 2.00 2.00 2.00	37.50 34.72 30.00 15.00 14.70 6.00 3.00 1.00 .00 .00 .00 .00 .00 .00	2841 2783 2604 2797 2365 2177 1976 1500 1318 1095 812 2650 2500 2481 2438 2216 2207 1480	1890.2 1870.4 1832.8 1653.4 1653.4 1653.6 1319.9 1044.7 747.2 861.6 7649.8 R 1381.4 1370.9 1381.4 1370.9 1381.4 1283.4 1265.7 1283.4 1265.7 1299.0 1109.8 1100.2 958.9 859.6 772.3	21.665 21.678 21.761 22.093 22.496 22.660 22.667 22.677 22.677 22.677 22.677 22.677 22.677 24.592 24.592 24.593 24.594 24.594 24.670 24.790 24.879 24.879 24.879 24.879	1-1267 1-1268 1-1272 1-1309 1-1424 1-1309 1-1208 1-2249 1-2262 , PERCE 1-1003 1-1249 1-1259 1-1259 1-1259 1-1259 1-1269 1	1.4091 1.3901 1.3929 1.1062 1.1052 1.9209 1.7701 1.0106 1.020 1.407 1.4064 1.3916 NT FUEL 0.8140 1.7799 1.807 1.7200 1.72	### ##################################	.0C135 .0C132 .0C102 .0C103 .0	-926 1.000 1.191 1.630 1.642 2.152 2.200 2.831 3.629 4.008 4.5460 -23.810 0.000 .92 .566 .772 .915 1.000 1.118 1.612 2.140 2.512 2.883	213.0 212.4 213.8 233.5 234.2 261.7 280.1 275.9 313.1 323.8 332.8 342.6 348.7 353.8 213.4 192.5 186.9 187.9 203.8 204.8 226.3 240.5 252.4	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163 2.140 1.056 1.056 1.007 1.013 1.325 1.339 2.286 7.339 2.349 1.056 1.05	.381 .51b .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.638 1.913 1.940 1.999 0.000 .1999 0.000 .1999 0.100 .1999	65.7.8 88.8 104.6 112.6 88.8 104.6 112.6 1
2.00 4.00 4.00 10.00 20.00 100.00 200.00 400.00 100.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00 1.	37.50 34.72 30.00 12.00 14.70 6.00 3.00 1.00 .03 .02 60.00 .7.14 20.00 42.88 37.90 34.33 30.00 14.70 6.00 3.00 14.70 6.00	2841 2821 2783 2604 2377 2367 2177 1706 1503 1916 1095 945 812 2652 2652 2652 2652 2782 2782 2782 2782 2782 2782 2782 27	1890.2 1870.4 1832.8 1803.6 1409.0 1409.0 1419.9 1044.7 973.1 649.8 R 1381.4 1370.9 1342.7 1310.0 1283.4 1283.	21.665 21.678 21.161 24.033 24.043 24.043 24.057 22.667 22.677 22.677 24.677 24.677 24.076 25.006 25.006	1-1267 1-1268 1-1272 1-1309 1-1310 1-1424 1-1309 1-1408 1-2420 1-2420 1-2420 1-2520 1-1029 1-1029 1-1029 1-1024 1-1029 1-1024 1-1029 1-1024 1-1029 1-1024 1-1029 1-1024 1-1029 1-1024 1-1029 1-1029 1-1029 1-1029 1-1029 1-2403 1-2403 1-2403 1-2403 1-2403 1-2403 1-2403 1-2403	1.4091 1.3901 1.3929 1.1032 1.1032 1.9209 7.701 1.0166 1.0166 1.02 1.02 1.03 1.0499 1.05 1.03 1.05 1.05 1.05 1.05 1.05 1.05 1.05 1.05	864 861 824 821 774 621 538 537 2 4-00 631 848 840 631 846 759 690 632 759	.0C135 .0C132 .0C102 .0C103 .0	-926 1.0000 1.131 1.640 2.152 2.2831 3.273 3.629 4.008 4.546 4.986 5.460 0.000 .292 .2061 1.000 1.118 1.612 2.140 2.512 2.813	213.0 212.4 213.8 233.5 234.2 261.7 280.1 275.9 313.1 323.8 342.6 348.7 353.8 342.6 105.4 11	1.052 1.005 1.005 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163 2.140 1.248 1.007 1.000 1.003 1.325 1.339 2.286 3.629 5.877 11.319	.381 .51b .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.838 1.940 1.999	65:7:88-8 88-8 104-6 126-3 175-2 112-6 126-3 175-2 290-7 305-0 316-9 338-0 30-2 58-1 191-7 123-1 191-7 213-1 191-7 213-1 230-2 248-1
2.00 4.00 4.00 20.00 100.00 200.00 200.00 200.00 400.00 100.00 2000.00 1.00 1.00 1.20 1.40 1.75 2.00 4.00 4.00 4.00 4.00 4.00 4.00 4.00	37-50 34-72 30-00 15-00 14-70 6-00 3-00 1	2841 2783 2604 2797 2365 2177 1976 1500 1318 1095 812 2650 2500 2481 2438 2216 2207 1480	1890.2 1870.4 1832.8 1653.4 1653.4 1653.6 1319.9 1044.7 747.2 861.6 7649.8 R 1381.4 1370.9 1381.4 1370.9 1381.4 1283.4 1265.7 1283.4 1265.7 1299.0 1109.8 1100.2 958.9 859.6 772.3	21.665 21.678 21.761 22.093 22.496 22.660 22.667 22.677 22.677 22.677 22.677 22.677 22.677 24.592 24.592 24.593 24.594 24.594 24.670 24.790 24.879 24.879 24.879 24.879	1-1267 1-1268 1-1272 1-1309 1-1424 1-1309 1-1208 1-2249 1-2262 , PERCE 1-1003 1-1249 1-1259 1-1259 1-1259 1-1259 1-1269 1	1.4091 1.3901 1.3929 1.1062 1.1052 1.9209 1.7701 1.0106 1.020 1.407 1.4064 1.3916 NT FUEL 0.8140 1.7799 1.807 1.7200 1.72	### ##################################	.0C135 .0C132 .0C102 .0C103 .0	-926 1.000 1.191 1.630 1.642 2.152 2.200 2.831 3.629 4.008 4.5460 -23.810 0.000 .92 .566 .772 .915 1.000 1.118 1.612 2.140 2.512 2.883	213.0 212.4 213.8 233.5 234.2 261.7 280.1 275.9 313.1 323.8 332.8 342.6 348.7 353.8 213.4 192.5 186.9 187.9 203.8 204.8 226.3 240.5 252.4	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 208.163 2.140 1.056 1.056 1.007 1.013 1.325 1.339 2.286 7.339 2.349 1.056 1.05	.381 .51b .607 .653 .732 1.016 1.022 1.276 1.427 1.552 1.685 1.768 1.638 1.913 1.940 1.999 0.000 .1999 0.000 .1999 0.100 .1999	65.7.8 88.8 104.6 112.6 88.8 104.6 112.6 1
2.00 4.00 4.00 4.00 10.00 20.00 100.00 200.00 400.00 100.00 100.00 100.00 1.00 1	37.50 34.72 30.00 15.00 14.70 6.00 3.00 1.50 .03 .02 .03 .02 .03 .03 .03 .03 .03 .03 .03 .03	2841 2703 2604 2777 2365 2177 1978 1706 1505 1318 1095 945 812 2655 277 277 277 277 277 277 277 277 277 2	1890.2 1870.4 1892.8 1693.6 1693.6 1497.9 1917.9 1917.9 1944.7 747.2 801.6 703.1 649.8 1381.4 1370.9 1342.7 1910.4 1263.7 1270.9 1283.4 1283.6 1299.8 12	21.665 21.6761 22.093 22.496 22.660 22.6673 22.677 22.677 22.677 22.677 22.677 22.677 24.677 24.677 24.994 24.972 24.972 24.972 24.972 24.972 25.0006 25.0008	1-1267 1-1268 1-1272 1-1309 1-1310 1-1424 1-1309 1-2122 1-2306 1-2429 1-2249 1-2262 7 PERCE 1-1503 1-1510 1-1519 1-1519 1-1519 1-1519 1-1519 1-1519 1-1519 1-1519 1-1519 1-2627 1-2627 1-2627 1-2627 1-2627 1-2627 1-2627	1.4091 1.3901 1.3901 1.1032 1.1062 1.9209 1.7701 1.0100 1.02	864 861 821 821 774 621 566 510 438 337 438 848 849 631 848 849 631 649 653 575 690 653 575 690 653 575 690 653 575 690 653 575 690 653 653 653 653 653 653 653 653 653 653	.0C135 .0C132 .0C132 .0C109 .0	-926 1.0000 1.191 1.642 2.152 2.200 2.831 3.273 3.629 4.008 4.546 4.946 5.460 0.000 .772 .915 1.000 1.118 1.612 2.140 2.912 2.883 3.3883 3.3883 3.483 4.407	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 348.8 342.8 34	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 0.557 12.980 21.822 36.754 73.335 123.637 208.163 2.140 1.246 1.056 1.007 1.013 1.325 1.362 5.877	-381 -51b -607 -653 -732 1-016 1-022 1-276 1-427 1-552 1-685 1-768 1-899 0-000 1-999 0-000 1-999 -611 -664 -736 1-023 1-	65:7: 88-8 80:44 60:46 612-6 6
2.00 4.00 4.00 2.00 100.00 200.00 100.00 200.00 400.00 100.00 100.00 1.00 1.00 1.0	37.50 34.72 30.00 15.00 14.70 6.00 3.00 1.50 .03 .02 .03 .02 .03 .03 .02 .03 .03 .03 .03 .03 .03 .03 .03	2841 2703 2604 2777 2365 2177 1778 1700 1500 1318 1095 812 2650 2500 2481 2418 2210 2210 12418 12418 2119 1480 12418 124	1890.2 1870.4 1892.8 1693.6 1693.6 1497.9 1917.9 1944.7 1947.2 801.6 703.1 649.8 1381.4 1370.9 1342.7 1310.6 1283.4 1265.7 1239.0 1109.8 1106.2 958.9 859.6 772.3	21.665 21.6761 22.073 22.073 22.660 22.6673 22.677 22.677 22.677 22.677 22.677 22.677 22.677 24.070 24.070 24.074 24.070 25.000 20.000	1-1267 1-1268 1-1272 1-1309 1-1424 1-1305 1-1008 1-2122 1-2306 1-2430 1-2249 1-2362 7 PENCE 1-1503 1-1510 1	1.4091 1.3901 1.3929 1.1062 1.1052 1.9209 1.7701 1.106 1.106 1.107	### ##################################	.0C135 .0C132 .0C102 .0C103 .0	-926 1.0000 1.131 1.642 2.152 2.200 2.831 3.273 3.629 4.008 4.546 4.946 4.946 4.946 5.460 -23.810 0.000 .772 .815 1.000 1.118 1.612 1.625 2.833 3.388 3.388 3.783	213.0 212.4 213.8 233.5 234.2 261.7 280.1 295.9 313.1 323.8 332.8 342.6 348.7 353.8 213.4 197.5 186.9 187.9 203.8 204.8 226.3 240.5 252.4 260.3	1.052 1.005 1.000 1.015 1.353 1.368 2.412 3.941 6.557 12.980 21.822 36.754 73.335 123.637 206.163 2.140 1.246 1.056 1.007 1.013 1.325 1.339 2.877 11.339	-381 -515 -607 -653 -732 1-016 1-022 1-276 1-427 1-552 1-685 1-768 1-685 1-999 0-000 1-1999 0-000 1-1999 1-529 1-644 1-023 1-268 1-023 1-268 1-023 1-0	65.7. 88.8 104.6 112.6 1

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(a) Concluded. Combustion-chamber pressure, 60 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, μ,	Thermal conductivity, k,	number	Specific impulse in vacuum,		Thrust coefficient;	Specific impulse I,
P _c /P	Mo∕sqin. obs	°K	cal/g	901	γ	col/(g)(°K)	micro poises	col/(sec)(°K)(cm)		I voc. (lb)(sect/lb	ε	C ^E	;Ib)(sec)/
		1	F	= 4+000	PERCE	NT FUEL		1 0/F			l	L	
1.00	60.00	2347		26.257	1.1871	0.5285	798	0.00050	0.000			0.000	
1.05	57.14	2350	1045.8	26.265	1.1885	-5247		•00049	• 2B7	307.2	2.165	.202	27.
1.20	50.00	2282	1022.5	26.286	1.1925	•5073	784	+00047	•557		1.260	• 388	52 •
1.40	42.86 37.50	2228	996.2 974.0	26.307 26.323	1.2013	•4905 •4772	772 761	+00045 +00044	•760 •902	174.0	1.061	•524 •616	71. 83.
1.78	33.79	2143	957.0	26.334	1.2046	.4674	753	+00042	1.000	168.5	1.000	•67₺	92•
2.00	30.00 15.00	2101	937.9 834.6	26.345	1.2084	.4269 .4102	743 685	•00041	1.103	169.1	1.297	1.019	100.
4.08	14.70	1051	831.7	26.388	1.2278	•4092	083	•00035 •00034	1.612	182.5	1.311		139.
10.00	6.00	1556	717.0	26.403	1.2503	.3769	605	•00029	2.146	201.1	2.192	1.263	171.
20.00	3.00	1351	641.3	26.406	1.2627	•3619	547	•00025	2.537	212.9	3.439	1.397	189.
40.00	1.50	1167	575.7	26.406	1.2738	•3501	491	•00022	2.926	222.8	5.518	1.504	204.
200.00	•60 •30	954 815	502.8 456.7	26.406 26.406	1.2393	•3354 •3244	372	•00016 •00018	3.452	233.3	10.507 17.236	1.615	219.
400.00	•15	692	417.5	26.406	1.3121	.3141	326	•00013		245.0	28.358		235.
000+00	•06	553	374.8	26.406	1.3349	•3013	. 470	•00011	4.951	250.6	54.842	1.792	243.
000.00	•03 •02	464 387	344.3	26.406	1.3456	•2929	232 197	•00009	5.484		90.278 148.471	1.627	247. 251.
000.00	•02		326.2		1.3563	•2865	<u> </u>	•00008	6.070		140.471	1.033	
	. 1							58, U/F		· 			
1.00	60 • 00 57 • 14	2062	855.0	27.299 27.302	1.2228	0.4109	740 736	0+00037 +00037	0.000 .283	282.2	2.186	0.000	25 •
1.20	50.00	1995	826.1	27.309	1.2280	•4004	724	+00036	•550	178.9	1.269	.392	48.
1.40	42.86	1938	806.0 787.4	27.316 27.321	1.2323	• 3925	710		•751 •892	159.3 154.7	1.066	529	65.
1.80	37.50	1849	771.7	27.324	1.2300	.3864 .3016	688 698	•00033 •00033	1.000	153.9	1.000	.621	7 6 • 85 •
2.00	30.00	1811	757.4	27.327	1.2414	•3175	679	•00032	1.093	154.3	1.007	747	92.
4+00	15.00	1576	672.1	27.336	1.2520	.32/9	617	•00025	1.094	105.7	1.282	1.022	126.
4-08	14.70	1571	66Y.7	21.336	1.2200	.30/5	615	•000∠8	i.607	166+1	1.295	1.029	127.
20.00	6 • 00 3 • 00	1304	576.3 515.3	27.338	1.2707	•3413 •3309	237 484	•00043 •00040	2.549	192.6	2.145 3.345	1.261	155.
40.00	1.50	961	462.9	27.339	1.2928	•3209	432	00019	2.946		5.334	1.496	184.
100.00	•60	778	405.1 369.0	27.339 27.339	1.3094	•3076	367	•00015	3.486	210.3 215.8	10.072		197.
200.00 400.00	•30 •15	659 555	338.5	27.339	1.3227	.2979 .2888	321 279	•00011 •00012	4.379		26.810	1.666	205. 212.
000.00	•06	438	305.6	27.339	1.3536	.2763	230	•00008	>.047	225.0	51.370	1.771	248.
000.00	•03 •02	365 303	285.4 268.6	27.339 27.339	1.3632 1.3097	•2728 •2693	195 164	•0000°	5.611		84.029 137.526	1.804	222.
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TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Combustion-chamber pressure, 150 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure	Static pressure,	Temp- erature,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, μ,	Thermal conductivity,	Mach number	Specific impulse	Area ratio,	Thrust coefficient	Specific impulse
ratio, P _c /P	P, Bo∕iqin	Ť, K	h, coł/g	weight,	exponent,	cal/(g)(°K)*	micro	k, col/(sec)(°K)(cm)	M	in vacuum, I _{vac,}	ratio, E	C _F	I. (#)(sec)/(6
	abı				<u> </u>	l	poises	l	<u> </u>	(Hb)(sec)/Hb		L	
				0.150					= 1.19	0		1	
1.00	150.00	1183	5313.5 5287.7	4.416 4.416	1.3396	1.7752	314	0.00073	C+000	530.0	2.250	0.000 -210	47.
1.05	142.86	1129	5218.7	4.416	1.3436	1.7597	303	•00070	.527	334.2	1.297	.403	90•
1.40	107.14	1085	5141.8	4.416	1.3469	1.7473	293	•00068	•722	296.1	1.081	.543 .636	122.
1.60 1.87	93.75 80.42	1049	5077.7 5006.8	4.416	1.3497	1.7368	285 276	•00066 •00063	.860 1.000	286.6	1.018	.725	143.
2.00	75.00	989	4975.4	4.416	1.3541	1.7210	272	•00062	1.059	284.4	1.003	.761	171.
4.00	37.50	824	4693.4	4.416	1.3651	1.6825	234	•00052	1.566	301.7	1.233	1.031	232.
10.00	15.00	643	4392.5	4.416	1.3748	1.6505	186	•00042	2.152		1.974 1.997	1.257	283. 284.
20.00	14.70 7.50	639 532	4386.6 4209.0	4.416	1.3750	1.6591	187	•00041 •00035	2.286		2.982	1.376	309.
40.00	3.75	439	4058.9	4.416	1.3824	1.6269	133	+00049	9.031	356.4	4.620	1.467	330.
100.00	1.50	340	3899.0		1.3882	1.6091	104	•00023	3.648	169.8	8.432	1.558	350+
400.00	• 75 • 38	280	3802.6 3723.2	4.416	1.3923	1.5571	85 70	•00018 •00015	4.149	377.7 384.1	13.431 21.488	1.610	362.
į					1.4350	1.4845	55	•00011	5.438	390.6	39.928	1.694	381.
1000 • 00 2000 • 00	•15 •08	175	3640.1 3590.9	4.416	1.4552	1.4387	45	+00009	6.096	394.3	63.572	1.719	287.
4000.00	-04	114	3551.2	4.416	1.4710	1.4054	36	•00007	6.844	397.3	100.938	1.739	391.
			·	- 0.200	, PERCE	NT FUEL	= 38 • 6	55. O/F	= 1.58				
1.00	150.00 142.86	1514	2969.7	5.216 5.216	1.3078	1.6191	402 399	0.00084	C+000	552.1	2.233	0.000	0 • 49 •
1.20	125.00	1450	2866.8	5.216	1.3119	1.6026	389	•00081	.533	348.6	1.289	• 400	94.
1.40	107.14	1390	1.685ء	5.216	1.3154	1.5889	378 369	•00078 •00076	.730 .869	299.6	1.077	.539 .632	127.
1.60	93.75 81.24	1354	2713.2	5.216	1.3217	1.5652	359	•00073	1.000	297.3	1.000		169.
2.00	75.00	1282	2601.1	5.216	1.3236	1.5585	353 307	*00072 *00061	1.068	297.8 316.7	1.004	• 757	179. 243.
4.00	37.50	1079	2290•0	5.216	l	1	-		1]			
10.00	15.00	852	1954.3 1947.7	5.216 5.216	1.3558	1.4516	251 250	•00048 •00048	2.148	344.7	2.009	1.257	297.
20.00	7.50	709	1748.8	5.216	1.3655	1.4232	213	•00040	4.573	362.0	3.049	1.379	325.
40.00	3.75	288	1578.0	5.216	1.3714	1.4067	179	•00034	2.010	376.0	4.739	1.472	348.
100.00	1.50	458	1396.3	5.216	1.3770	1.3914	142	•00026	: 619	390.5 399.1	8 - 679	1.565	370.
200.00 400.00	.75	379	1286.1	5.216	1.3861	1.3007	117	*00018	4.111	406.1	22.295	1.662	
				i	1.3972	1.3402	74	•00013		413.4	41.979	1.706	405.
1000+00 2000+00	•15 •08	242 198	1098.9	5.216	1.4104	1.2958	61	•00011	6.01Z	417.7	67.687	1.733	409.
4000.00	•04	161	993.9	5.216	1.4344	1.2500	50	•00009	6.706	421.1	100.754	1.754	414.
'		•	F	- 0.250	, PERCE	NT FUEL	= 33·!	51. O/F	= 1.984	•		•	•
1.00	150.00	1816	1249.3	6.016	1.2820	1.5040	481	0.00092	(.000	T		0.000	0 -
1.05	142.86	1797	1220.2	6.016	1.2831	1.4992	477	•00091	.277	563.4	2.218	•207 •398	50.
1.20	125=00 107+14	1745	1142.1	6.016	1.2860	1.4867	467	•00089 •00086	.538	356.2	1.283	.536	96.
1.60	93.75	1000	981.5	6.016	1.2921	1.4616	. 446	.00064	.876	306.6	1.015	.629	152.
1.63	81.96	1587	910.0	6.016	1.2950	1.4503	436	•000#0	1.000	304.5	1.000	•708 •754	171.
2.00 4.00	75.00 37.50	1555	863.9 535.1	6.016 6.016	1.3125	1.3875	378	.00068	1.578	325.5	1,256	1.027	249.
10.00	15.00	1027	176.1	6.016	1.3329	1.3225	514	+00054	2.147	355.3	2.048	1.258	305.
10.21	14.70	1052	169.0	6.016	1.3333	1.3213	312	+00054	4.159	355.9	2.073	1.262	206.
40.00	7.50 5.75	741	9954.0 9768.1	6.016	1.3461	1.2847	269 228	•00046 •00038	2.963	373.7	3.127 4.883	1.382	335. 359.
													1
100.00 200.00	1.50	581	9569.1 9447.6	6.016	1.3663	1.2320	181	-00030 -00025	4.064	404.2	8.985 14.396	1.574	382.
400.00	-38	399	9347.3	6.016	1.3755	1.2100	125	•00020	4.582	420.9	23.208	1.675	406.
1000-00	-15	310	9240.5	6.016	1.3819	1.1723	95	-0001>	: +327	420.7	43.894	1.722	418.
2000+00 4000+00	•00	256 210	9175.9	6.016	1.4039	1.1003	76	•00012	£ .545	433.4	71.200	1.749	424.
+000+00		210		L	L	1	1		L	L	1		L
		,		= 0.300					= 2.381	1	1		,
1.00		2092	9932.7	0.813	1.2595	1.4348	550 547	0.00099	C • 000	560.4	2.205	206	50.
1.20	125.00	2015	9823.6	6.814	1.2627	1.44111	537	•00095	. 242	359.7	1.277	. 395	97.
1.40	93.75	1951	9734.4	6.815	1.2503	1,3931	525	•00092 •00090	•742 •882	319.8 310.3	1.070		131. 154.
1.60	82.58	1846	9590.3	6.815	1.2723	1.3659	505	•00087	1.000	300.5	1-000	- 700	172.
2.00	75.00		9539.0		1.2744	1.3567	498	•00086 •00074	1.082	309.0	1.006	1.023	185.
4.00	37.50			i									
10.00	15.00	1256	8825.4 8817.9	0.810 5.815	1.1042 VV0t.1	1.2322	3/2	•00000		361.8		1.259	310.
	7.50	1064	6.1950	0.510	1.3240	1.1891	5∠5	•00051	4.255	201.2	3.200	1.386	341.
40.00	3.75	875	8393.7	0.616	1.3304	1.1551	479	•00044	4.760	397.0	1 60.00	1.460	355.
40+00	I .	706	8100.4	6.016	1.3550	1.1175	223	د د 000 .	2.544		9.325	1.584	190.
	1.50			1	1.3602	1.1008	187	+00027	4.013			1.642	
40.00 100.00 200.00	• 75	590	8049.7	6.816			15n	•00074	4.517	431./	24-235	1.689	416-
40.00 100.00 200.00 400.00	• 75 • 36	+90	7940.9	0.816	1.3600	1.0000	150	•00023	4.517	431.2	24.235	1	1
40.00 100.00 200.00	.75 .36			6.816			150 120 98	*00017	:.246 :.851	431.2 439.6 444.6 448.7	46.002 74.917	1.738 1.767	428.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature	Enthalpy,	Molecular weight,	Isentropio		Viscos- ity,	Thermal conductivity	Mach	Specific impulse	Area	Thrust	Spe
P _c /P	fb/sq in obs	°K	col/g	300	γ	C _{p,} col/(g)(^o K)	μ, micro	k, col/(sec)(°K)(ce	M	in vacuum I vac	ε	coefficient C _F	imp
	·		<u> </u>	R = 0.35	O. PERC	ENT FUEL	poises = 26.	L	= 2.77	(lib)(sec)/lib			11000
1.00	150.00	2339	8892.8	7.604	1.2338	1.4271	610	0.00107	1 0.000			1	Т
1.05	142.86	2317	8663.1	7.605	1.2352	1.4164	606	0.00107 .00106	0.000		2.192	0.000	
1.20 1.40	125.00			7.607			597	•00102		360.7	1.271	. 393	9
1.60	93.75		8618.1				585 576	•00099			1.067		
1.80	83.19			7.612	1.2502	1.3209	567	+00093		309.8	1.000		15
2.00 4.00	75.00 37.50		8496.3	7.613 7.615			559 506	•00091 •00079		310.7 333.1	1.007	.748	18 25
10.00	15.00		7767.3	7.616			434	•00065	2.148	365.6	1	1 -	31
20.00	14.70 7.50		7759.5 7524.4	7.616 7.616			433	•00065	2.160	366.2	2.147	1.265	31
40.00	3.75		7317.8	7.616			381 330	+00055 +00046	2.549	385.8 402.4			34 37
100.00	1.50		7092.8	7.616			267	•00036				1.594	39
400.00	•75 •38		6953.8	7.616 7.616			225 189	•00030 •00025	3.963 4.452	430.2 438.6			41 42
1000.00	•15	460	6713.0	7.616	1.3634	.9789	148	+00019	5-160	447.5	48.312	1	43
2000.00 4000.00	•08 •04	382 317	6574.0	7.616 7.616	1.3683	.9694	121 98	•00016 •00013	5.750 6.390	452.8 457.2	78.890	1.784	44
			F	= 0.400) PERCE	ENT FUEL	= 23.9	L	= 3 - 175				
1.00	150.00		8050+5	8.379		1.4879	660	0.00118	0.000		T	0.000	
1.05	142.86	2532	8021.1 7941.9	8.382	1.2108	1.4725	657 648	*00±16	-284	566.8	2.178	.203	5
1.40	107.14	2410	7852.7	8.393	1.2194	1.3894	637	•00112	•552 •754	359.6 320.4	1.265	.391	9 13
1.60	93.75 83.84	2353	7777.5	6.398	1.2235	1.3555	628	+00104	.895	311.3	1.011	.619	15
2.00	75.00	2260	7655.7	8.401	1.2269	1.3293	620	-00101 -00098	1.000	309.7	1.000	-686	17
4.00	37.50	1978	7308.9	8.413	1.2491	1.1954	561	00084	1.594	334.1	1.286	.745 1.021	18: 25:
10.00	15.00	1638	6918.4		1.2695	1.1133	489	•00069	2-147	367.5	2.155	1.261	31
20.00	14.70 7.50	1631	6910.5	8.416 8.416	1.2699	1.1119	488	•00069	2.159	368.2	2.182	1.266	31
40.00	3.75	1206	6455.6	8.416	1.2991	1.0256	435 380	•00059 •00050	2.542	388.5 405.8	3.358 5.344	1.393	346
100.00	1.50	971	6220.8	8.416		.9769	313	•00040	3.479	424.0	10.047	1.604	399
400.00	• 75 • 38	819 688	6074.6 5951.6	8.416 8.416	1.3317	.9479 .9251	266	•00033 •00027	3.917 4.388	434.9	16.311 26.573	1.666	414
000.00	•15	543	5819.0	8.416	1.3536	•9040	176	•00021	5.072	453.3	50.851	1.771	440
000.00	•04	452 376	5737.8	8.416	1.3595	.8930 Seas	146	•00017	5.644	458.9	83.253	1.803	446
				l			119	+00014	6.266	463.6	136.502	1.829	455
	75.					NT FUEL			* 3.571				
1.00	150.00 142.66	2733	7354.5 7325.6	9.133	1.1879	1.6077	701	0.00132	0.000			0.000	C
1.20	125.00	2659	7247.6	9.148	1.1925	1.5881	698	.00130 .00125	•287 •557	562.0 357.0	2.165 1.259	•202 •388	50 96
1.40	107.14	2596	7159.7	9.159	1.1966	1.4792	681	•00119	•760	318.4	1.061	524	130
1.60	93.75 84.52	2542	7085.3	9.168	1.2004	1.4330	672	•00115	•902	309.6	1.009	.616	153
2.00	75+00	2451	6964.7	9.181	1.2070	1.3621	658	+00111 +00107	1.000	308.3	1.000	•678 •742	168
4.00	37.50	2171	6610.6	9.200	1.2202	1.19>1	610	•00089	1.599	333.6	1.298	1.019	253
10.00	15.00 14.70	1819	6224.7	9.215	1.2523	1.0768	541 539	•00073	2.145	368.0	2.193	1.263	313
20.00	7.50	1578	5971.1	9.216	1.2004	1.0750	486	•00072 •00063	2.156	368.7	2.221 3.436	1.267	314
40.00	3.75	1359	5751.9	9.216	1.2808	.9835	430	•00054	2.922	407.6	5.502	1.504	373
200.00	1.50	939	5509.0	9.216	1.3006	•9330	359	•00043	3.450	426.6	10.428	1.614	400
00.00	.38	794	5227.1	9.216 9.216	1.3250	•9001 •8730	308 262	•00036 •00030	3.673 4.327	438.1 447.5	17.026 27.879		417 430
00.00	-15	631	5086.9	9.216	1.3417	.8467	207	•00023	4.986	457.5	53.635		444
00.00	•08 •04	528 440	5000.6 4928.4	9.216	1.3501	.8316	172	•00019	5.536	463.5	88.103	1.823	452
1	L	I.		= 0.500;		1 FUEL =	20.12		3.968		144.834	1.851	459
1.00	150.00	2881	6769.6	9.859	1.1704	1.7727		0+00149	0.000			0.000	0
1.05	142.86	2862	6741.4	9.866	1.1713	1.7501	733	.00147	.289	555.6	2.153	-201	49
1.40	107-14	2752	6579.0		1.1771	1.6893	726 717	.00141 .00134		353.3	1.254	. 386	95
1.60	93.75	2701	6>06.0	9.915	1.1802	1.5642	710	*00129	·908	307.0	1.008	.614	128. 151.
2.00	75.00		6454.3		1.1825	1.5246	704 '		1.000	305.7	1.000	.671	165
4.00	37.50		6044.3		1.2061	1.2448	653			307.1	1.311		182. 251.
10.00						1.0652	287			367.4	2.235	1.265	312.
10.21 20.00					1.2339	1.0625	586	•00077	2.154	368.1	2.264	1.270	?13.
40.00					1.2499	•9956 •9502	478			389.6 408.2			346. 373.
00.00	1.50	1242	4919+2	10.015	1 10 0					ĺ		ļ	
00.00					1.2900	.8794 .8042	405			428.0			-01
00.00	• 38		4626.0		1.3121	-8340	301			440.0 450.0			٠١٥. ١٤٠:
00.00	• 15				1.3208	-8019	241	•0004>	4.901	460.5		-	.46.
00.00	• 08	608		10.016		.7843	202	•00021	5.431	466.8			.55.
00.00	• 04			10.016		• 7700	167	-00017		472.1	154.133	1.874 4	62.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OX'GEN

(b) Continued. Combustion-chamber pressure, 150 pounts per square inch absolute; equilibrium composition during isentrolic expansion

ressure	Static pressure,	Temp erature,	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, #,	Thermal conductivity, k.	Mach number	Specific impulse in vacuum,	, 00,	Thrust coefficient, C _F	I.
P _c /P	No/sqin.	T, °K	col/g	707	γ	c _{p,}	micro	K, col/(sec)(°K)(<m)< th=""><th>M </th><th>I_{vac.} (lb)(sec)/lb</th><th>ε</th><th>Ct.</th><th>(lb)(sec)/(</th></m)<>	M	I _{vac.} (lb)(sec)/lb	ε	Ct.	(lb)(sec)/(
				= 0.600	. DERCE	NT FUEL		15. O/F	= 4.76			-	
		r					788	0.00191	0.000			0.000	0.
1.00	150+00 142+86	3097 3081	5841.6 5815.0	11.228	1.1465	2.2005 2.1752	788 786		.292	540.2	2.136	.199	48.
1.05	125.00	3036	5742.8	11.268	1.1479	2.1055	780	+00181	•>67	344 • 0	1.247 1.055	.383	92. 125.
1.40	107.14	2985	5661.1	11.300	1.1493	2.0248	773 766	•00173 •00167	•774 •918	299.6	1.007	.610	147.
1.60	93.75 86.09	2940 2911	5591.6	11.326	1.1517	1.9107	764		1.000	298.7	1.000	.661	159.
2.00	75.00	2865	5478.2	11.368	1.1535	1.8396	756		1.122	300.4 326.4	1.013	.735 1.017	245.
4.00	37.50	2630	5146.9	11.479	1.1562	1.5032	720	•0012+	1.618	32044	*****	1	
10.00	15.00	2308	4756.B	11.570	1.1922	1.1596	666		2.143	363.4	2.321	1.270	307•
10.21	14.70	2300	4748.7	11.572	1.1928	1.1536	665	.00091 .00075	2.154	364.1 386.9	2.352 3.708	1.275	3084
20.00	7.50	2058	4497.3	11.602	1.2142	3.0010 .9136		•000f	2.867	406.6	6.038		370.
40.00	3.75	1017	1			ļ	i	-	2 260	427.8	11.693	1.652	399.
100-00	1.50	1518	4006.8		1.2517	.8515 .8157	493		3.360	440.9	19.413	1.726	417.
200.00	.75 .38	1317	3838.9	11.616	1.2798	7825	383		4.158	451.9	32.319	1.787	432.
400.00	• ,0		1				1 776		4.742	463.6	63.444	1.853	448.
000.00	.15	924	3532.7	11.616	1.2988	.7435 .7189	314 267	+00030		470.7	105.595	1.893	457
000.00	•08 •64		3431.6	11.616	1.3238	6994	224	-00040			175.548	1.927	466
				70	DERCE	NT FUEL	= 15.	25. O/F	= 5.55	6			
			7	12.482	+	2.7036	825	Ţ	T	r		0.000	
1.00	150.00 142.86	3231	5138.3	12.482	1.1328	2.6609	623	•00237	.294	523.5	2,126		89
1.20	125.00	3176	5045.5	12.536	1.1328	2.6171	515 511				1.242 1.052		
1.40	107.14	3130	4968.6	12.580	1.1329	2.5409		•002:5	.923		1.006	-607	143
1.60	93.75 86.66		4862.0	12.640	1.1333	2.4518	803	•002. I	1.000		1.000		
2.00	75.00	3025	4795.9	12.580	1.1338	1.9694					1.015		
4.00	37.50	2823	4480.4	12.855	1.1306	1.9074	, , ,	•002.0		1			
10.00	15.00	2550				1.4750					2.391		
10.21	14.70	2544		13.044	1.1539	1.4650					3.886	1.424	335
20.60 40.00	7.50			13.187		.9713					6.425	1.547	364
40.00					[0.24	1 - 74	•000-9	3.296	424.8	12.637	1.677	395
100.00	1.50	1797				.8356 .7371					21.191	1.756	413
400.00	• 75 • 38	1579				.7520				450.8	35.638	1.825	429
40000			1 -				394	.000:5	4.593	463.7	70.952	1.898	447
1000.00	-15									471.7	119.341	1.94	457
4000+00	•04							•000 5	5.523	478.4	200.371	1.98	466
			L	R = 0.80	0. PEKC	ENT FUEL	= 13	60, O F	= 6.34	9	•		
_ ,	150.00	3304			1	3.1245	-r	- T - '	0.000)		0.000	0
1.00	142.86	3290		13.639	1.1255	1098 و د	645	• 00- 0	.295	506.9			6 45
1.20	120.00	3253	4499.9			3.0677	844						117
1.40	93.75				1.1240	2.9681	83	40021	.927	282.2			
1.60	86.9	1 3154	4331.9	13.814	1.1237	2.9401	830		1.000				
2.00	75.00	3115	4265.3				79						
4.00	37.50	2935	3967.3	14.095	1.1220			i		1		, , ,-	292
10.00	15.00		3606.7		1.1267	2.0604					2.472	1.28	
10.21	14.70				1.1269	1.642			2.>05	373.0	4+01	7 1.43	1 327
20.00 40.00	7.5					1.262			2.829	394.9		3 1.55	356
		1			1.1840	.924.	64	7 .ooc!	1 3.240	419.2	13.61	1.69	586
100.00						.799	3 59	8 • 00C >	3.57	434.4	23.110	5 1.78	408
400.00							5 54			447.3	39.26	7 1.85	9 424
			2327.4	14.816	1.2401	-6930	47	2 .000+	4.44	461.5	79.18	5 1.94	
2000.00							41	7 -0003	4.60			9 1.99	
4000.00							1 36	4 •0002	5.30	2 477.9	228.32	2.03	
				R = 0.90	O PERC	ENT FUE	= 12	•28• C/					- ,
1.00	150.0	0 7 333	6 4142.	14.65	1.1226	3.285		0 0.00 3	0.00	9 491.1	2.11	0.00	
1.05	142.8	6 : 332.	2 4120.	14.67.	1.1224		7 86		5 .57	3 313.4	1.23	9 .38	0 84
1.20		0 328				3.220	3 85	7 .0029	1 .78	2 280.4	1.00	1 .51	
1.00		5 321	1 3935.	7 14.840	1.120	1 3.199	7 05		7				
1.72	87.0	9 319							0 1.13	4 274.8	1.01	6 .73	1 16
2.00	1 75.0	0 31> 0 298				2.966			6 1.63	6 300.6	1.36	0 1.01	6 22
4.00	!				1	ļ	Ì.	6 .00.2	0 /-15	1 338 • 0	2.45	7 1.27	9 28:
10.00	15.0									2 338.8	2.49	3 1.28	4 284
20.00		0 277					B 76	.00:8	9 2.51	0 363.4	4.08	2 1.43	
40.00								17 -00:5	6 2.83	5 385.4	6.96	0 1.56	
				1	7 1.155	6 1.398	5 65	9 -00-0	8 3.23	B 410-5			
100.00		0 226			5 1.106			·0037	8 3.54	9 427.	3 24.99	6 1.80	
200 • 00 400 • 00				6 10.19	3 1.1d7		8 04	(O • O O J 5	9 3.83	441.	43.40	9 1.88	3 41
		1	-	1 15 62	1.213	3 .672	:د ا ر	400-4	1 4.28	8 457.			
		5 162	8 1744.	1 10.41	7 10613	-1 .036		-00		أأينا الما			
2000-00		8 145			6 1.226	9 .627		00 4 00 5	0 4.67			8 2.01	

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio, P _c /P	Static pressure, P, Ib/sgin.	Temp- erature, T,	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat, c _{p.}	Viscos- ity, #,	Thermal conductivity, k,	Mach number M	Specific impulse in vacuum, I voc.	Area ratio,	Thrust coefficient, C _F	L
'c / '	abs	°K		, , , , , , , , , , , , , , , , , , ,	γ	cal/(g)(°K)	poises	cal/(sec)(°K)(cm)	L	(lb)(sec)/lb		1	(b)(sec)/(
		,		1.000	PERCE	NT FUEL	= 11.	19, O/F	= 7.93	7			
1.00	150.00	3341	3777.9		1.1217	3.1852	882	0.00295	0.000 .295	476.5	2.118	0+000 •197	42.
1.05	142.86 125.00	3328 3292	3757.1 3701.0	15.664	1.1214	3.1630	875	•00291	.573	303.9	1.238	•380	81.
1.40	107.14	3252	3637.1	15.735	1.1197	3.1421	869	.00287	•782	272.2	1.050	-514	110.
1.60	93.75 87.13	3217	3582.7 3553.1	15.766	1.1150	3.1225 3.1111	864	.00283	1.000	265.5	1.005	.606 .650	139
2.00	75.00	3161	3493.4	15.000	1.1178	3.0866	056	-00278	1.134	266.7	1.016	.731	157-
4.00	37.50	2994	3228.9	16.167	1.1146	2.9493	637	•00258	1.636	291.8	1.361	1.016	218.
10.00	15.00	2789	2907.0	16.532	1.1117	2.7109	799	•00229	2.162	328.3	2.462	1.279	275 .
20.00	14.70 7.50	2765	2900•1 2682•4	16.539	1.1116	2.4914	798 775	*00228 *00205	2.172	352.8	2.498 4.097	1.434	308.
40.00	3.75	2505	2472.8	17.043	1.1107	2.2430	752	•00180	2.837	374.7	7.007	1.566	337.
100.00	1.50	2325	2217.2	17.345	1.1135	1.8808	719	.00145	3.244	400+0	14.608	1.712	368.
200-00	•75	2188	2039.0	17.547	1.1188	1.5942	692	-00120	3.542	416.7 431.6	25.757 45.624	1.807	389.
400.00	.38	2048	1873.6	17,718	1.1202	1.3134	662	•00096	3.034	432.6			1
1000.00	•15	1850	1674.1	17.886	1.1497		575	00069	4.220	448.7	97.111 170.978	2.051	427.
4000.00	•08 •04	1688	1538.1	17.962	1.1732	-8018 -6840	527	•00054 •00043	4.853	469.5	298.702	2.107	453.
		L		1 = 1.500	L	!	= 7•	749, O/F	=11•905	L		1	i
1.00	150.00	3219	2626.1	19.176	1.1249	1.9992	905	0.00193	0.000			0.000	0.
1.05	142.86	3206	2609.8	19.199	1.1247	1.9899	903	•00191	•295	421.7	2.120	-198	37•
1.40	125.00	3169 3127	2565.9 2515.9	19.260	1.1242	1.9637	897	.00188	•572 •781	268.9	1.240 1.051	.515	97.5
1.60	93.75	3091	2473.3	19.390	1.1233	1.9032	885	-00180	.927	234.8	1.005	-606	115.
1.72	86.98 75.00	3071	2449.6 2403.5	19.424	1.1232	1.8526	881	•00178 •00173	1.000	234.2 235.8	1.000	.651 .732	123.
2.00 4.00	37.50	2853	2197.1	19.783	1.1223	1.6765	845	.00152	1.633		1.357		193.
10.00	15.00	2626	1947.2	20.134	1.1249	1.4088	806	•00123	2.158	289.4	2.439	1.278	243.
10.21	14.70	2621	1942.0	20.141	1.1250	1.4026	805 774	•00123 •00102	2.169	310.5	2.474 4.027	1.283	244.0
20.00 40.00	7.50 3.75	2455	1774.4	20.361	1.1306	.9827	740	-00102	2.834	329.0	6.805	1.559	296.
					1.1651	• 7495	687	•00360	3.249	349.7	13.824	1.700	323.0
100.00 200.00	1.50 .75	2037 1842	1424.2	20.710	1.1881	-6298	641	•00048	3.566	362.8	23.681	1.789	340 -
400.00	• 38	1644	1180.0	20.602	1.2093	•5593	589	•00040	3.903	374.0	40.495	1.865	354.
1000.00	•15	1393	1047.3	20.811	1.2308	.5103	517	•00033	4.391	386.3	82.105	1.948	370 • 6
2000.00 4000.00	•08 •04	1220	960.9 885.4	20.813	1.2441	.4869 .4666	463	+00028 +00024	5.226	394.0 400.5	139.978 238.311	2.001	389.2
4000.00	1	1	1	⊥	1	L	1	927. U/F	1.	ł	L	1	L
		т		r	T	T		T	T	T		1 2 222	
1.00 1.05	150.00 142.86	3045	2016+0	21.610	1.1322	1.3351	900	0.00130 .00129	0.000	386.3	2.126	0.000	34.
1.20	125.00	2992	1965.5	21.688	1.1323	1.2984	891	•00126	•571	246.2	1.242	.381 .516	66.
1.40	107•14 93•75	2947	1923.6 1886.0	21.752	1.1326	1.2665	883	+00122	.778	220.3	1.052		205.0
1.73	86.67	2886	1867.2	21.838	1.1331	1.2211	872	•00116	1.000	214-2	1.000		113-1
2.00 4.00	75.00 37.50	2845 2649	1829.6 1657.8	21.895 22.145	1.1336	1.1894	865	+00113 +00095	1.129	215.6	1.015		176.
4.00			1			_			2 161	١.,,	2 302	1.275	221.
10.00 10.21	15.00 14.70	2388	1451.9	22.405	1.1514	.8231 .8187	778 777	•00073 •00072	2.151	263.1	2.393	1.280	222.4
20.00	7.50	2184	1311.8	22.540	1.1681	•6852	736	•00059	2.502	281.4	3.895	1.424	247-9
40.00	3.75	1974	1185.0	22.621	1.1892	-5809	688	•00048	2.839	297.0	6.456	1.547	200.
100.00	1.50	1694	1037.6	22.665	1.2166	.4985	618	•00038	3.291	313.9 324.5	12.741		291.6
200 • 00 400 • 00	.75	1492	940+9 856+0	22.675	1.2328	.4656 .4438	562	+00048	3.652	324.5	21.403 36.042	1.828	317.
		1	_	-		İ		i	4.576	143.1	71.914	1.904	330+6
2000.00	•15	1084 935	760+3 699+0	22.677	1.2629	•4209 •4053	434 382	•00023 •00020	5.01	349.1	121.231	1.948	33000
4000.00	•04	803	646.3	22.677	1.2892	-3906	334	•00017	5.495	354+1	204.087	1.986	345.2
	1		I	R = 3.000	D. PERCE	NT FUEL	= 4.	031. 0/F	=23 • 81	0			+
1.00	150.00	2695	1381.4			0.7383		0.00072	0.000	I		0.000	0.0
1.05	142.86	2679	1370.8	24.628		•7306 •7094	856	•00071 •00069	.291	216.5	2.145		30 • 58 •
1.20 1.40	107-14	2582	1309.9	24.706	1.1635	.6854	837	-00066	•769	193.4	1.057	•520	78 •
1.60	93.75 85.58	2537	1282.4	24.739	1.1661	.6513	828 822	•00063 •00062	1.000	188.4	1.007		101.
1.75 2.00	75.00	2462	1237.6	24.789	1.1707	.6319	513	•00059	1.116	188.6	1.012	.737	111.
4.00	37.50	2226	1107.7	24.905	1.1886	•5411	762	•00049	1.610	204+4	1.320	1.017	154.
10.00	15.00	1914	956.0	24.980		.4569	590	•00039	2.142	226.7	2.271		192+
10.21	14.70	1907	953.5 a57.4	24.981	1.2161	.4575 .4232	688 632	•00038 •00033	2.154	240.8	2.301 3.601		
20.00 40.00	7.50 3.75	1475	770.4	25.006	1.2473	.4015	574	•00029	2.891		5.831		
	1	1227	672.4	25.008	1.2631	.3516	499	•00024	3.397	265.4	11.232	1.637	248.
100 00	1.50	1224	604.6	25.008	1.2752	.3682	445	•00021	3.796	273.2	18.588	1.708	259.
100.00			555.6	25.008		.3559	394	-00018	4.217	∠79.8	30.867	1.767	268.
	-38	1	1										
200.00	خ 15	736	495.9		1.3049	.3401			4.816		60.444	1.829	277.
200.00 406.00	į .	ľ	495.9 458.5 426.8	25.008	1.3101	•3401 •3292 •3196	∠86	-00012	5.312	291.0	60.444 100.439 166.664	1.868	277. 283. ∠88.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIEND PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OX/GEN

(b) Concluded. Combustion-chamber pressure, 150 pounts per square inch absolute; equilibrium composition during isentroic expansion

Pressure ratio, P _C /P	Static pressure, P, B/sq in.	Temp- erature, T,	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, #,	Thermal conductivity,	number	Specific impulse in vacuum		Thrust coefficient,	Specific impulse I,
'c / '	obs	°K	ca/ p	אני	γ	col/(g)(°K)	poises	cal/(sec)(⁰ K)(cm)	м	I vac.	ε	c,	: 1, :fb)(sec)/(i
			F	R = 4.000	PERCE	ENT FUEL	= 3.	054. O/F	#31 • 74·	6			
1.00	150.00	2363	1054.4	26.287	1.1944	0.5005	802	0+00041	0.000		;	0.000	0 • 0
1.05	142.86	2344	1045.7	26.294	1.1957	•4958 •4833	798 787	•0004°	•286 •556		2.169 1.261	•202 •389	27•
1.40	107.14	2238	995.9	26.328	1.2037	.4699	774	+00044	.758	174.4	1.062	•525	71.
1.60	93.75 84.31	2188	973.6 956.3	26.341	1.2075	•4590 •4509	763 754	•0004÷	1.000		1.010	•617	83.8
2.00	75.00	2107	937.5	26.359	1.2138	•4426	745	•00041	1.101	169.4	1.009	.743	100-9
4.00	37.50	1859	834.0	26.391	1.2322	•4044	685	•00034	1.599	182.4	1.275	1.020	138.5
10.00	15.00 14.70	1555	716.5 714.1	26.404	1.2512	•3757	605	•0002£	2.148		2.187	1.263	171.5
20.00	7.50	1350	640.8	26.406	1.2629	•3752 •3616	604 547	•00026 •00025	2.160	201.5 213.0	3.431	1.267	172+1
40.00	3.75	1166	575.3	26.406	1.2739	-3500	491	•00022	2.928	222.9	>+506	1.504	204 - 2
100.00	1.50	953	502.5	26.406	1.2894	•3353	421	-00018	3.455		10.485	1.614	41).2
400.00	.75 .38	814 691	456.5 417.3	26.406 26.406	1.3021	•3244 •3140	372 326	•00016 •00013	3.873	239.8 245.1	17.201 28.301	1.680	228.1
1000 00	16	550									 I		
2000.00	•15 •08	552 463	374.6 348.1	26.406	1.3330	•3012 •2928	270 232	+00011 +00009	4.955 5.487	250.6 254.0	54.731 90.095	1.791	243.2
4000+00	•04	367	326.0	26.406	1.3563	-2864	197	•00007	6.075	256.8	148.169	1.854	251.7
			R	- 5.000	PERCE	NT FUEL	= 2.4	58, O/F	=39.683)			
1.00	150.00 142.86	2066 2048	855.0 847.7	27.307		0.4020	741	0.00037	0.000			0.000	0.0
1.20	125.00	1998	828.0	27.315	1.2282	.3996 .3934	737 725	•00036 •00035	• 283 • 549	179.0	2.108 1.269	• 204 • 392	40.4
1.40	107.14 93.75	1941 1892	805.9 787.3	27.321	1.2353	.3869 .3818	711	•00034	• 750	159.3	1.066	•529	65.3
1.60	83.45	1850	771.5	27.327	1.2410	.3777	688	•00033 •00032	.891, 1.000;	153.9	1.011	•622 •690	76 • 7 85 • 2
2+00	75.00 : 37.50	1812	757.3 672.0	27.329	1.2433	•3742 •3570	679	•00032 •00028	1.092	154.4	1.007 1.281	-747	92.2
		İ	i			- :					i		126.2
10.00	15.00 14.70	1303	576.2 574.3	27.338	1.2708	•3411 •3408	539	•00023 •00023	2.152	182.5	2.144	1.262	155.7
40.00	7.50 3.75	1122 961	515.2 462.8	27.339	1.2815	3309	484	-00020	2.550	192.6	3.343	1.393	171.9
1				i		.3209	432	.00018	2.947	∠01•2	5.332	1.496	184.7
100.00	1.50	778 658	405.1 369.0	27.339 27.339	1.3094	•3076 •2979	367 321	•00015 •00012	3.487	210.3 215.8	10.068	1.666	197.9
400.00	- 38	554	338.5	27.339	1.3364	.2887	279	•00011	4.380	220.3	26.799	1.717	205.6
1000.00	•15	438	305.6	27.339	1.3536	.2782	229	*00008		225.0	51.350	1.771	218.7
000.00	•08 •04	365 303	285.4	27.339	1.3632	•2728 •2693	195 164	•00007	5.612 6.235	227.8	83.996 137.472	1.803	222.6
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TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Combustion-chamber pressure, 300 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	weight.	isentropic exponent,	Specific heat,	Viscos- ity, µ,	Thermal conductivity,	Mach number	Specific impulse in vacuum,		Thrust coefficient,	Specific impulse, I,
P _c /P	lb√sqin. obs	°K	col/g	2002	γ	p, col/(g)(^K)	micro poises	col/(sec)(°K)(cm)	м	I _{voc.}	ε	Ct	.No it sec i/til
		L	F	R = 0.150	PERCE	NT FUEL	<u> </u>	1	= 1.19			L	
1.00	300.00	1183	5313.5	4.416	1.3396	1.7752	314	0.00073	0.000			0.000	0•0
1.05	285.71	1168	5287.7	4.415	1.3406	1.7710	311	•00073	.271	530.1	2.250	•210	47.4
1.20	250.00	1129	5218.6	4.416	1.3436	1.7597	303	•00070	•527 •722	334.2 296.1	1.297	.543	90.8
1.40	214.29 187.50	1049	5141.9	4.416	1.3469	1.7369	285	•00068 •00066		250.1	1.018		143.
1.87	160.84	1008	5006.8	4.416	1.3527	1.7257	276	•00063	1.000	284 • l	1.000	• 725	163.
2.00	150.00	989	4975.4	4.416	1.3540	1.7210	472	•00062		284.4	1.003	• 761	232.
4.00	75.00	824	4693.4	4.416	1.3651	1.6825	234	•00052	1.566	7 • 10 و	1.233	1.031	2324
10.00	30.00	643	4392.5	4.416	1.3748	1.6505	188	+00042	2.152	±27.5	1.974	1.257	283+
20.00	15.00	532	4209.8	4.416	1.3799	1.6344	159	ځد000 ٠	2.586	343.5	2.982	1.376	309.
20.41	14.70	529 439	4204.9	4.416	1.3801	1.6339	158 133	•00035 •00029	2.599 3.031	343.9	3.020 4.620	1.379	310.
40.00	7.50	439	403049	. 4.410	1.5024	1.020							
100.00	3.00	340	3899•0		1.3880	1.6099	104	•00023	3.648	369.8	8.432 13.431	1.558	350.
200.00	1.50	280	3802.5	4.416	1.3923	1.5970	70	•00018 •0001>	4.149	377.7 384.1	21.488	1.654	374.
400.00	• 75	230	312342	7.410		1,033,11		-0000		;			
1000.00	• 30		3640.1	4.415		1.4840	55	•00011	5.437	390.6	39.928 63.572	1.694	381.
2000.00	•15 •08		3590.9	4.416	1.4551	1.4387	45 36	•00009 •00007	6.096	397.3	100.938	1.739	
4000.00	• 0 a	L 117			L		L					L	
			,	R = 0.200		NT FULL		т	= 1.58	, 			
1.00	300.00	1514	2969 • 7	5.216	1.3078	1.6188	402 399	0.00084	0.000	552.2	2.233	0.000 .209	49.
1.05	285.71 250.00	1497	2941.7	5.216	1.3119	1.6025	389	.00081	.533	348.6	1.289		94.
1.40	214.29	1398	2783.2	5.216	1.3154	1.5889	378	•00078	-730	309.3	1.077	.539	127.
1.60	187.50	1354	2713.2	5.216	1.3185	1.5773	369	00076	.869	299.6 297.3	1.016	.632 .716	149.
1.85	162.47	1307	2640.5	5.216	1.3217	1.5652	359	•00073 •00072	1.000	297.8	1.000	.757	179.
2.00	75.00	1079	2290.0	5.216		1.5046	307	•00061	1.572	316.7	1.244	1.029	243.
• • •									2.148	344.7	2.009	1.257	297.
10.00	30.00 15.00	709	1740.8		1.3559	1.4232	251	•00048	2.573	362.0		1.379	325
20.00 20.41	14.70	705	1743.2		1.3008	1.4225	212	•00040	2.586	362.4	3.088	1.382	326.
40.00	7.50	588	1578.0	5.216	1.3715	1.4065	179	-00034	3.010	376.0	4.739	1.472	348.
	2 00	458	1396.3	5.216	1.3771	1.3913	142	•00026	3.619	390.5	8.679	1.565	370•
200.00	3.00 1.50	379	1286.1	5.216	1.3811	1.3807	117	•00022	4.111	399.1	13.870	1.619	382.
400.00	.75	312	1195.2	5.216	1.3851	1.3677	96	•00018	4.638	406.1	22.296	1.662	393•
	30	24.2	1008.0	5 216	1.3972	1.3402	74	.00013	5.394	413.4	41.979	1.706	403.
1000.00 2000.00	•30 •15	242 198	1098.9	5.216	1.4156	1.2977	61	+00011	6.014	417.7	67.687	1.733	409.
4000+00	• 08	161	993.9	5.216	1.4349	1.2571	50	•00009	6.705	421.1	108.755	1.754	414.
				₹ = 0.250	PERCE	NT FUEL	= 33•	51, O/F	= 1.98	•			
1.00	300.00	1817	1249.3	6.016	1.2824	1.5015	481	0.00092	0.000			0.000	0.
1.05	285.71	: 1797	1220.2	6.016	1.2835	1.4971	477	•00091	.276		2.218	.207 .398	50 ·
1.20			1142.1	6.016	1.2863	1.4852	467 456	+00089	•538 •736	356.2	1.283	•536	130.
1.40	214.29	1686 1636	981.5	6.016	1.2895	1.4609	446	•00084	.876	306.6	1.015	.629	152.
1.60 1.83	163.91		909.9	6.016	1.2951	1.4498	436	•00081	1.000	304.5	1.000	-708	171.
2.00	150.00	1555	863.9	6.016	1.2971	1.4425	429	•00080	1.076	305.1	1.005	.754 1.027	183.
4.00	75•0₫	1322	535.1	6.016	1.3125	1.3875	378	•00068	1.578	325.5	1,270	1.021	2470
10.00	30.00	1057	176.1	6.016	1.3329	1.3226	314	+00054		355.3	2.048		305.
20.00	15.30	887	9954+0	6.016	1.3460	1.2849	269	+00046	2.563	373.7	3.127	1.382	335.
20.41	14.70	741	9948.0	6.016	1.3508	1.2838		•00045 •00038	2.987		4.883		359.
40.00	7.50	. 141	,,,,,,,,,,	3.010			1	İ			!	1	
100.00	3.00	581	9569+0		1.3663	1.2321		-00030	3.581	404.2 413.4	8.985		382.
200.00	1.50	399	9447.8		1.3716	1.2192	151	•00025 •00020	4.581	420.9	23.208		406.
400.00	•15	379				1					_		418.
1000.00	•30	310	9240.5		1.3820	1.1949	95 78	.00015 .00012	5.945	428.7 433.4	43.894	1.722	424.
2000.00 4000.00	•15 •0b	256 210	9175.9			1.1475		-00010	6.605		115.650	1.771	430.
		1			1	.1	I	57, 0/F	= 2.38	1	L	1	L
_,	,	v									т	0.000	
1.00	300.00	2093	9932.7	6.814	1.2600	1.4230	550 547	0.00098	0.000	568.5	2.206	0.000	
1.05 1.20	285.71		9903.1 9823.5	6.815	1.2611	1.4027	537	•00095	.542	359.8	1.277	.396	97.
1.40	214.29	1952	9734.4	6.815	1.2614	1.3869	525	+00092	•742	319.8	1.070	533	
1.60	187.50	1897	9659.4	5.615	1.2702						1.013		
1.82 2.00	165.12 150.00		9590.1 9538.9	5.816	1.2729	1.3023	498	• 00086	1.002	309-1	1.006	.751	185.
4.00	75.00		9199.7	6.816	1.2893			•00074	1.585	30.6	1.266	1.025	252.
				1	1 2001	1 2220	375	-00060	. 2.148	361.8	2.085	1.260	310
10.00	30.00	1257	8525.3 8591.2	6.816	1.3248	1.2336	375				3.206	1.386	
20.00	15.CO 14.70		8591.2		1.3293					381.7	3.248	1.390	342.
40.00	7.50		8393.6		1.3384						5.037	1.485	366
	i		1				223	د د 0000 و	1.544	413.5	9.325	1.584	390.
100.00	3.00		8180.4	0.016	1.3531	1.1173				423.3	14.993	1.642	404
200.00 400.00	1.50		7940.6	6.816	1.3603	1.0065					24.234		416.
			İ	1	i				5.247	439.6	46.000	1.738	428.
1000.00	.30	363	7524.8	. 6.816	1.3724		120	.00014		444.6	74.914		435.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P.	Temp- erature T,	Enthalpy,	weight,	Isentropic exponent,	Specific heat,	μ,	Thermal conductivity	number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	impuls
P _C /P	lb∕iqin. abs	°K	col/g	201	γ	cal/(g)(°K)	micro poises	k, col/(sec)(°K)(cr)		I vac.	ε	C*	I,
		1		2 = 0.35	0 - 0 E P C I	NT FUEL	·	.7. 015	= 2.778		L	1	İ
		T	8892.8			T			r	· 	1	Τ	
1.00	300.00 285.71	2344	8892.8	7.607		1.3936	610	0.00105	0.000 .281	569.6	2.194	0.000	
1.20	250.00	2263	8783.1	7.610		1.3629	597	•00101	.547	360.9	1.272	.393	
1.40	214.29	2196	8693.4	7.611	1.2463	1.3598	586	•00098	.747	321.1	1.068	.531	131
1.60	187.50	2139	8617.8	7.612		1.3219	576	•0009>	•888	311.7	1.012		154
2.00	150.00	2088	8496.0	7.613 7.614	1.2523	1.3072		•00093	1.000	309.9 310.8	1.000		172
4.00	75.00	1771	8151.2		1.2695	1.2310	506	.00079	1.590	333.2			254
10.00	30.00	1451	7766.9	7.616	1.2854	1.1057	434	•00065	2.149	365.6	4 310	1 161	23.2
20.00	15.00	1238	7524.1	7.616	1.3935	1.1205		•00055	2.549				
20.41	14.70	1232	7517.5	7.616	1.3040	1.1192	379	•00055	2.561	366.4	3,325		345
40.00	7.50	1051	7317.5	7.616	1.3168	1.0794	330	•00046	2.952	402.4	5.189	1.491	370
100.00	3.00	838	7092.6	7.616	1.3364	1.0365	267	•00035	3.511	419.8	9.678	1.594	395
200.00	1.50	702	6953.6	7.616	1.3474	1.0119	225	•00030	3.964	430.2	15.630	1.654	410
400.00	•75	586	6837.4	7.616	1.3503	.9954	189	•00025	4.453	438.6	25.355	1.703	422
1000.00	•30	460	6712.9	7.616	1.3633	.9791	148	•00u19	5.161	447.5	48.298	1.754	435
2000.00	• 15	362	5636.9	7.616	1.3604	.9692	121	•00016	5.751	452.8			443
4000.00	• 08	317	6573.9	7.616	1.3733	9596	98	•00013		457.2	128.975	1.903	449
			F	= 0.400	, PERCE	NT FUEL	= 23.9	5. 0/F			L		
1.00	300.00	2565	8050.5	8.389	1.2157	1.4207	662	0.00114	0.000	-		0.000	
1.05	285.71	2543	8021.0	8.390	1.2170	1.4084	658	•00112	•284	567.8		•204	50
1.20	250.00	2484	7941.5	8.395	1.2205	1.3764	649	•00109	.551	360.1	1.267	•391	97
1.40	214.29	2417	7852.1 7776.7	8.399 d.403	1.2247	1.3423	638 629 -	.00105 .00101	•753 •894	320.7 311.6	1.065	.528 .620	131
1.79	167.44	2310			1.2313	1.2941	621	•00099	1.000	310.0	1.000	.687	171
2.00	150.00		7714.6 7654.6	8.407	1.2342	1.2752	613	•00096	1.095	311.0	1.008	.746	185
4.00	75.00	1978	7307.8	8.414	1.2508	1.1857	561	•00083	1.594	334.2	1.285	1.021	254
10.00	30.00	1637	6917.4	8.416	1.2698	1.1119	489	•00069	2.148	367.6	2.152	1.262	314
20.00	15.00	1409	6668.4	5.416	1.2842	1.0671	434	•00059	2.044	388.5	3.354	1.393	346
20.41 40.00	14.70	1403	5661.6 5454.8	8.416 8.416	1.2846		433	•00059	2.555	389.1	3.399	1.397	347
40.00	7.50	1205	0424.0	0.410	1.2991	1.0255	380	•00050	2.939	405.6	5.338	1.497	372
100-00	3.00		6220.2		1.3168	.976d		•00040		424.1		1.603	399
400.00	1.50	819	6074.1		1.3316	9478	266		3.919		16.294	1.666	414
400.00	•75	667	5951.2	8.416	1.3428	•9250	224	•00027	4.390	443.9	26.545	1.717	427
1000-00	•30	542	5818.7	8.416	1.3537	•9038	176	•00021		453.3	50.799	1.770	440.
4000.00	•15 •08	452 376	5737.5 5670.0	8.416	1.3595	.8929 .8831	146	•00017	5 • 646	459.0	83.167	1.802	448
	•00	3,0			L			•00014		1	136.362	1.029	400
			R	= 0.450	 PERCE 	NT FUEL	= 21.8	7. 0/F	= 3.571				
1.00	300.00	2755	7354.5	9.152	1.1952	1.5003	705	0.00125	0.000	1		0.000	0 •
1.05	285.71	2734	7325.4	9.155	1.1964	1.4043	704	.00123	.286	263.6	2.169	-202	50·
1.20	250.00 214.29	2677	7247.0 7158.7	9.164		1.4419		•00119	• 256	357.9	1.261	.389	96.
1.40	187.50	2611	7084.0	9.173	1.2036	1.3959	683	.00114 .00110	•758 •700	319.1 310.2	1.062	•525 •617	130
1.78	168.67	2510	7026.0	9.185	1.2100	1.3312	668	•00107		308.8	1.000	-680	169
2.00	150.00		6962.9	9.190	1.2132	1.3023	660	•00104	1.102	310.0	1.009	.743	184
4.00	75.00	2173	6616.3	9.208	1.2319	1.1697	610	•00088	1.599	333.9	1.295	1.020	253
10.00	30.00	1818	6222.5	9.215	1.2529	1.0717	540	•00u72	2.147	368.2	2.187	1.263	313.
20.00	15.00	1576	5969.2	9.216	1.2667	1.0246	485	•00063	2.537	389.8	3.427	1.397	347.
20.41	14.70 7.50		5962.2	9.216	1.2671		483	•00063		190.3	3.474		348
		1320	5750.2	9.216	1.2810	.9831	430	• 00054	2.725	40/+/	5.487	1.503	373.
40.00	,,,,					- 1			1				
100.00	3.00		5507.6	9.216	1.3007	.9327	358	•00043	3.453	426.7	10.401	1.613	400
100.00	3.00 1.50	938	5355.2	9.216	1.3151	.9327 .8999	8¢6 806	•00036	3.877	430.2	16.963	1.613	400 • 417 •
100.00	3.00		5507.6 5355.2 5226.1	9.216 9.216 9.216	1.3007 1.3191 1.3281	.9327 .8999 .8728	358		3.877			1.613	417.
100.00 200.00 400.00	3.00 1.50 .75	938 793 630	5355.2 5226.1 5086.2	9.216 9.216 9.216	1.3151	.8748 .8748	358 308 261 207	•00036	3.877	430.2	16.983 27.808 53.499	1.613	
100.00 200.00 400.00	3.00 1.50 .75	938 793 630 527	5355.2 5226.1 5086.2 5000.0	9.216 9.216 9.216 9.216	1.3151 1.3281 1.3418 1.3501	.8728 .8728 .8465	358 308 261 207 172	•00036 •00030 •00023 •00019	3.877 4.331 4.990 5.541	438.2 447.6 457.6 453.6	16.983 27.808 53.499 87.879	1.613 1.678 1.732 1.788 1.821	417. 430. 444. 452.
100.00 200.00 400.00	3.00 1.50 .75	938 793 630 527	5355.2 5226.1 5086.2 5000.0	9.216 9.216 9.216 9.216 9.216	1.3151	.8728 .8728 .8465	358 308 261 207	.00036 .00030 .00023 .00019 .00016	3.877 4.331 4.990 5.541 6.144	438.2 447.6 457.6 463.6 468.5	16.983 27.808 53.499 87.879 144.468	1.613 1.678 1.732 1.788 1.821 1.849	417. 430. 444. 452.
100.00 200.00 400.00	3.00 1.50 .75	938 793 630 527	5355.2 5226.1 5086.2 5000.0 4927.9	9.216 9.216 9.216 9.216 9.216	1.3151 1.3281 1.3418 1.3501 1.3561	.8728 .8728 .8465 .8315 .8211	358 308 261 207 172 142	•00036 •00030 •00023 •00019	3.877 4.331 4.990 5.541 6.144	438.2 447.6 457.6 463.6 468.5	16.983 27.808 53.499 87.879	1.613 1.678 1.732 1.788 1.821 1.849	417. 430.
100.00 200.00 400.00	3.00 1.50 .75	938 793 630 527 440	5955.2 5226.1 5086.2 5000.0 4927.9	9.216 9.216 9.216 9.216 9.216	1.3151 1.3281 1.3418 1.3501 1.3561	.8728 .8728 .8465 .8315 .8211	358 308 261 207 172 142	•00036 •00030 •00023 •00019 •00016	3.877 4.331 4.990 5.541 6.144	438.2 447.6 457.6 463.6 468.5	16.983 27.808 53.499 87.879 144.468	1.613 1.678 1.732 1.788 1.821 1.849	417. 430. 444. 452.
100.00 200.00 400.00 1000.00 2000.00 4000.00	3.00 1.50 .75 .30 .15 .08	938 793 630 527 440 2915 2895	5355.2 5226.1 5086.2 5000.0 4927.9 R	9.216 9.216 9.216 9.216 9.216 = 0.500 9.891 9.897	1.3151 1.3281 1.3418 1.3501 1.3501 . PERCE	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042	358 308 261 207 172 142 = 20.1	.00036 .00030 .00023 .00019 .00016 2, O/F	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288	438.2 447.6 457.6 463.6 468.5	16.983 27.808 53.499 87.879 144.468	1.613 1.678 1.732 1.788 1.821 1.849	444. 452. 459.
100.00 200.00 400.00 1000.00 2000.00 4000.00	3.00 1.50 .75 .30 .15 .08	938 793 630 527 440 2915 2895 2841	5355.2 5226.1 5086.2 5000.0 4927.9 R 6769.6 6741.2 6664.3	9.216 9.216 9.216 9.216 9.216 9.216 = 0.500 9.891 9.897 9.911	1.3151 1.3281 1.3418 1.3501 1.3501 1.3501 . PERCE	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042 1.5535	358 308 261 207 172 142 = 20•1. 741 738 730	.00036 .00030 .00023 .00019 .00016 2. O/F	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .59	438.2 447.6 457.6 463.6 468.5	16.983 27.808 53.499 87.879 144.468	1.613 1.678 1.732 1.788 1.821 1.849	444. 452. 459.
100.00 200.00 400.00 1000.00 2000.00 1000.00	3.00 1.50 .75 .30 .15 .08	938 793 630 527 440 2915 2895 2841 2778	5355.2 5226.1 5086.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6	9.216 9.216 9.216 9.216 9.216 9.216 = 0.500 9.891 9.897 9.897 9.926	1.3191 1.3281 1.3418 1.3501 1.3561 . PERCE 1.1779 1.1788 1.1814 1.1847	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042 1.5935 1.4970	358 308 261 207 172 142 = 20.1	.00036 .00030 .00023 .00019 .00016 2, O/F 0.00139 .00137 .00132 .00126	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .259 .764	438.2 447.6 457.6 463.6 468.5 557.9 354.6 316.4	16.983 27.808 53.499 87.879 144.468	1.613 1.678 1.732 1.788 1.821 1.849 0.000 .201 .387 .523	417. 430. 444. 452. 459. 0. 49. 95.
100.00 200.00 400.00 1000.00 2000.00 1000.00 1.05 1.20 1.40 1.60 1.77	3.00 1.50 .75 .30 .15 .08 300.00 285.71 250.00 214.29 187.50 169.85	938 793 630 527 440 2915 2895 2841 2724 2724 2684	5355.2 5226.1 5086.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6 6504.1 6450.6	9.216 9.216 9.216 9.216 9.216 = 0.500 9.891 9.897 9.911 9.926 9.938 9.938	1.3151 1.3281 1.3418 1.3501 1.3501 1.3501 . PERCE 1.1779 1.1788 1.1814 1.1847 1.1878 1.1901	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042 1.5535 1.4970 1.4502 1.4168	358 308 261 207 172 142 = 20.1 741 738 730 721 713 707	.00036 .00030 .00019 .00016 2, O/F 0.00139 .00137 .00132 .00126 .00121	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .59	438.2 447.6 457.6 463.6 468.5 557.9 354.6 316.4 207.9 306.6	16.983 27.808 53.499 87.879 144.468	1.613 1.678 1.732 1.788 1.821 1.849	417. 430. 444. 452. 459. 0. 49. 95. 129.
1.00 200.00 400.00 1000.00 2000.00 1.00 1.05 1.20 1.40 1.60 1.77 2.00	3.00 1.50 .75 .30 .15 .08 300.00 285.71 250.00 214.29 187.50 169.85	938 793 630 527 440 2915 2895 2841 2778 2778 2724 2684 2633	5355.2 5226.1 5036.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6 6504.1 6504.1 6504.1 65384.7	9.216 9.216 9.216 9.216 9.216 9.891 9.891 9.891 9.926 9.938 9.946 9.938	1.3151 1.3281 1.3418 1.3501 1.3501 1.3561 . PERCE 1.1779 1.1788 1.1814 1.1847 1.1847 1.1878 1.1901 1.1932	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042 1.5535 1.4970 1.4502 1.4168 1.3760	358 308 261 207 172 142 = 20·11 741 738 730 721 713 707 99	.00036 .00030 .00023 .00019 .00016 2. O/F 0.00137 .00137 .00132 .00126 .00121	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .559 .764 .906 1.000 1.108	438.2 447.6 457.6 463.6 468.5 557.9 354.6 316.4 307.9 306.6 307.9	16.963 27.808 53.499 87.879 144.468 2.158 1.256 1.060 1.009 1.000	1.613 1.678 1.732 1.788 1.821 1.849 0.000 .201 .387 .523 .615 .674	417. 430. 444. 452. 459. 0. 49. 95. 129. 152. 166. 183.
100.00 200.00 400.00 1000.00 2000.00 1000.00 1.05 1.20 1.40 1.60 1.77	3.00 1.50 .75 .30 .15 .08 300.00 285.71 250.00 214.29 187.50 169.85	938 793 630 527 440 2915 2895 2841 2724 2724 2684	5355.2 5226.1 5086.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6 6504.1 6450.6	9.216 9.216 9.216 9.216 9.216 = 0.500 9.891 9.897 9.911 9.926 9.938 9.938	1.3151 1.3281 1.3418 1.3501 1.3501 1.3501 . PERCE 1.1779 1.1788 1.1814 1.1847 1.1878 1.1901	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042 1.5535 1.4970 1.4502 1.4168 1.3760	358 308 261 207 172 142 = 20.1 741 738 730 721 713 707	.00036 .00030 .00019 .00016 2, O/F 0.00139 .00137 .00132 .00126 .00121	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .259 .764 .906 1.000	438.2 447.6 457.6 463.6 468.5 557.9 354.6 316.4 207.9 306.6	16.983 27.808 53.499 87.879 144.468 2.158 1.256 1.060 1.009 1.009	1.613 1.678 1.732 1.788 1.821 1.849 0.000 201 .387 .523 .615 .674	417. 430. 444. 452. 459. 0. 49. 95. 129. 152. 166. 183.
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1:00.00 2:00.00 4:00.00 1:000.00 1:000.00 1:05 1:20 1:40 1:40 1:40 1:40 1:77 2:00 4:00	3.00 1.50 .75 .30 .08 300.00 285.71 250.00 244.29 187.50 169.85 150.00 75.00	938 793 630 527 440 2915 2845 2841 2778 2724 2633 2352 1992 1740	5355.2 5226.1 5086.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6 6504.1 6450.6 0384.7 6040.6 5389.3	9.216 9.	1.3151 1.3241 1.3418 1.3501 1.3501 1.3501 1.1788 1.1788 1.1818 1.1818 1.1818 1.1901 1.1932 1.2121 1.2221	.8999 .8728 .8465 .8315 .8211 NT FUEL 1.6231 1.6042 1.5935 1.4970 1.458 1.3700 1.1932 1.9916	358 308 261 207 172 142 = 20•11 731 730 721 707 699 604	.00036 .00030 .00023 .00019 .00016 2. O/F .00137 .00137 .00132 .00126 .00121 .00118 .00114 .00094	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .59y .764 .906 1.000 1.604	438.2 447.6 457.6 463.6 468.5 257.9 354.6 316.4 207.9 306.6 307.9 32.6	16.963 27.80d 53.499 87.879 144.468 1.256 1.060 1.000 1.010 1.307 2.224	1.613 1.678 1.732 1.788 1.821 1.849 0.000 201 .387 .523 .615 .674 .740 1.019	444. 452. 459. 0. 495. 129. 152. 166. 183. 251.
1.00 200.00 400.00 400.00 1000.00 1000.00 1000.00 1.05 1.20 1.40 1.60 1.77 2.00 4.00	3.00 1.50 .75 .30 .15 .08 300.00 245.71 250.00 244.29 187.50 159.60 30.00 15.00	2915 2840 2915 2845 2841 2724 2644 2633 2352 1992 1740 1732	5355.2 5226.1 5036.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6 6504.1 6450.6 5384.7 6040.6 5389.3 5382.3	9.216 9.216 9.216 9.216 9.216 9.216 9.891 9.897 9.911 9.926 9.938 9.946 9.993 10.012 10.015	1.3151 1.3241 1.3418 1.3501 1.3501 1.3501 1.779 1.1788 1.1847 1.1847 1.1847 1.1848 1.1901 1.1902 1.2121	.8949 .8728 .8465 .8315 .6211 .6221 .6042 1.5035 1.4970 1.4902 1.4168 1.3766 1.3766 1.3766 1.9902 .9916	358 308 261 207 172 142 = 20·1 741 738 730 721 707 099 054 753 551	.00036 .00030 .00019 .00016 2.	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .259 .764 .906 1.000 1.108 1.604 2.145 2.529 2.529	438.2 447.6 457.6 463.6 463.6 468.5 557.9 354.6 316.4 307.9 332.6 367.7 389.9 399.9	16.983 27.808 53.499 87.879 144.468 1.256 1.060 1.009 1.010 1.307 2.224 3.504	0.000 .201 .387 .2387 .2387 .2387 .2387 .249 .240 .240 .240 .240 .240 .240 .240 .240	444. 430. 444. 459. 0. 495. 129. 152. 166. 183. 251. 312. 346. 347.
1.00 200.00 400.00 400.00 1000.00 1000.00 1.05 1.20 1.40 1.60 1.77 2.00 4.00	3.00 1.50 .75 .30 .08 300.00 285.71 250.00 244.29 187.50 169.85 150.00 75.00	938 793 630 527 440 2915 2895 2841 2724 2684 2724 2684 2352 1992 1740 1732 1509	5355,2 5226.1 5036.2 5000.0 4927.9 R 6769.6 6741.2 6664.3 6577.6 6504.1 6450.6 6384.7 6040.6 5389.3 5389.3 5389.3	9.216 9.	1.3151 1.3241 1.3418 1.3501 1.3501 1.3501 1.779 1.1788 1.1814 1.1847 1.1874 1.1901 1.1901 1.1902 1.2121	.8949 .8728 .8465 .8315 .8211 1.6231 1.6231 1.6042 1.5535 1.4970 1.44502 1.4168 1.3700 1.1932 1.9902 .9916	358 308 261 207 172 142 = 20•11 731 730 721 707 699 604	.00036 .00030 .00023 .00019 .00016 2. O/F .00137 .00137 .00132 .00126 .00121 .00118 .00114 .00094	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .59y .764 .906 1.000 1.604	438.2 447.6 457.6 463.6 468.5 257.9 354.6 316.4 207.9 306.6 307.9 32.6	16.963 27.80d 53.499 87.879 144.468 1.256 1.060 1.000 1.010 1.307 2.224	1.613 1.678 1.732 1.788 1.821 1.849 0.000 201 .387 .523 .615 .674 .740 1.019	444. 430. 444. 459. 0. 495. 129. 152. 166. 183. 251. 312. 346. 347.
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100.00 200.00 400.00 1000.00 1000.00 1000.00 1000.00 1.05 1.20 1.40 1.60 1.77 2.00 4.00 20.41 4.00 10.00 20.41	300.00 1.50 .75 .08 300.00 285.71 250.00 214.29 187.50 169.85 150.00 75.00 30.00 14.70 7.50	938 793 630 527 440 2915 2845 2841 2774 2684 2633 2352 1992 1740 1732 1509	5355.2 5226.1 5000.0 4927.9 R 6769.6 6741.2 664.3 6577.6 6504.1 6450.6 6384.7 6040.6 6384.7 6040.6 6384.7 6040.6 6384.7 645.6 6384.7 645.6	9.216 9.216 9.216 9.215 9.215 9.215 9.897 9.897 9.991 9.926 9.993 10.012 10.015 10.016 10.016	1.3191 1.3241 1.3418 1.3501 1.3501 1.3501 1.3501 1.1788 1.1788 1.1849 1.1849 1.1849 1.1902 1.2121 1.2209 1.2504 1.2504 1.2649 1.2649 1.2899 1.2893 1.2893 1.2893 1.2893	.8949 .8728 .8728 .8465 .8315 .6211 .81 FEL .6042 1.6042 1.5035 1.4970 1.4970 1.4902 1.4168 1.3766 1.1792 1.0006 .9916 .9902 .9441 .8488 .8488	358 308 261 207 172 142 = 20•1 741 738 721 721 707 699 654 554 554 404 350	.00036 .00030 .00023 .00019 .00016 2. O/F .00137 .00132 .00124 .0014 .00114 .00094 .00096 .00097	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .599 .764 .900 1.108 1.600 1.108 2.145 2.249 2.940 2.940 2.940 3.837	438.2 447.6 457.6 463.6 468.5 557.9 354.6 316.4 307.9 326.6 307.9 390.5 408.4 428.2 440.2	16.y63 27.b0d 53.49y 187.879 144.468 1.256 1.000 1.010 1.010 1.307 2.224 3.504 3.504 3.505 2.642 10.777 17.699	1.613 1.678 1.788 1.821 1.849 0.000 .201 .387 .523 .615 .615 .740 1.019 1.265 1.405 1.405 1.405 1.405 1.405 1.651	417. 430. 444. 452. 459. 0. 495. 129. 152. 166. 547. 373. 401. 418.
100.00 200.00 400.00 000.00 000.00 000.00 1.05 1.20 1.40 1.60 1.77 2.00 4.00 10.00 20.41 4.00 20.00 20.00 20.00 4.00 20.00	300.00 300.00 285.71 250.00 214.29 187.50 189.85 190.00 150.00 14.70 7.50 30.00 15.00 1	938 793 630 527 440 2915 2895 2841 2724 2684 2724 2683 2352 1740 1730 1730 1730 1740 1750 1750 1750 1750 1750 1750 1750 175	5355-2 5226-1 5000-0 4927-9 R 6769-6 6741-2 664-3 6577-6 6904-1 6450-6 6384-7 6040-6 5389-3 5389-3 5389-3 5389-3 5389-3 5496-1	9.216 9.216 9.216 9.215 9.215 9.215 9.897 9.991 9.925 9.938 9.946 9.993 10.015 10.016 10.016 10.016	1.3151 1.3241 1.3261 1.3501 1.3501 1.3501 1.3501 1.1788 1.1788 1.1847 1.1847 1.1848 1.1901 1.1902 1.2121 1.2099 1.2044 1.2099 1.2044 1.2892 1.2044 1.2892 1.2892 1.2892 1.2892 1.2992 1.2893 1.2893 1.2992 1.3123	.8949 .8728 .8728 .8460 .8315 .6211 .81 FEL .6042 1.6042 1.5035 1.4970 1.4970 1.4902 1.4902 1.4108 1.3706 1.9916 .9916 .9902 .9491 .8988 .8538 .8538	358 308 261 207 172 142 142 = 20·1 741 738 730 721 707 099 004 087 533 531 477 404 350 300	.00036 .00030 .00023 .00019 .00016 22, O/F .00137 .00132 .00124 .00141 .00114 .00094 .00096 .00096 .00097	3.877 4.331 4.990 5.541 6.144 	438.2 447.6 457.6 463.6 468.5 257.9 354.6 316.4 307.9 306.6 307.9 332.6 408.4 408.4 428.2 440.2 450.1	16, y63 27, 800 53, 499 87, 879 144, 468 1, 256 1, 060 1,	0.000 1.821 1.824 0.000 2.01 3.87 5.23 6.15 6.74 7.740 1.401 1.405 1.511	417. 430. 444. 452. 459. 0. 49. 129. 152. 166. 347. 373. 401. 418.
1.00 .00 200.00 400.00 .000.00 .000.00 .000.00 .000.00 .000.00 1.00 1.40 1.4	300.00 1.50 .75 .30 .15 .08 .255.71 .250.00 .214.29 .187.50 .159.85 .150.00 .150.00 .14.70 .150.00 .15	938 793 630 527 440 2915 2895 2841 2778 2724 2633 2352 1992 1740 1732 1509 1240 902 722	5355-2 5226-1 5086-2 5000-0 4927-9 R 6769-6 6577-1-2 6664-3 6577-6 6504-1 6450-6 6384-7 6040-6 5389-3 5382-2 5166-1 4916-8 4758-9 4624-2 4477-1	9.216 9.216 9.216 9.216 9.216 9.216 9.897 9.991 9.926 9.938 9.946 9.993 10.012 10.015 10.016 10.016 10.016	1.3191 1.3241 1.3261 1.3501 1.3501 1.3501 1.3701 1.179 1.179 1.1847 1.1847 1.1849 1.1901 1.1902 1.2101 1.2092 1.2092 1.2013 1.2643 1.2833 1.2833 1.2833 1.3123	.8949 .8748 .8340 .8310 .6211 NT FUEL 1.6231 1.6242 1.5935 1.4470 1.4470 1.4164 1.3700 .9916 .9902 .9941 .8638 .8638 .8336	358 308 261 207 172 142 = 20·1 741 738 730 721 713 707 99 654 567 567 567 567 567 567 567 567 567 567	.0003e .00030 .00012 .00012 .00015 .00016 22	3.877 4.331 4.990 5.541 6.144 3.968 0.000 .288 .906 1.000 1.108 1.604 2.145 2.540 2.910 3.427 3.827 4.275 4.900	498.2 447.6 457.6 463.6 468.5 57.9 354.6 316.4 307.9 307.9 397.9 397.9 397.9 408.4 428.2 440.2 450.1	16, y63 27, 490 53, 499 67, 879 144, 468 1, 256 1, 060 1,	1.613 1.678 1.788 1.788 1.842 1.849 0.000 .201 .387 .523 .615 .674 .740 1.265 1.401 1.401 1.401 1.511 1.624 1.624 1.624	417. 430. 444. 452. 459. 0. 49. 152. 166. 183. 251. 314. 3347. 373. 401. 418. 432. 446.
1.00 .00 200.00 400.00 1.00 .00 1.05 1.20 1.40 1.40 1.77 2.00 4.00 20.40 10.00 20.40	300.00 300.00 285.71 250.00 214.29 187.50 189.85 190.00 150.00 14.70 7.50 30.00 15.00 1	938 793 630 527 440 2915 2895 2841 2724 2684 2724 2683 2352 1740 1730 1730 1730 1740 1750 1750 1750 1750 1750 1750 1750 175	5355-2 5226-1 5000-0 4927-9 R 6769-6 6741-2 664-3 6577-6 6904-1 6450-6 6384-7 6040-6 5389-3 5389-3 5389-3 5389-3 5389-3 5496-1	9.216 9.216 9.216 9.215 9.215 9.215 9.897 9.991 9.925 9.938 9.946 9.993 10.015 10.016 10.016 10.016	1.3151 1.3241 1.3261 1.3501 1.3501 1.3501 1.3501 1.1788 1.1788 1.1847 1.1847 1.1848 1.1901 1.1902 1.2121 1.2099 1.2044 1.2099 1.2044 1.2892 1.2044 1.2892 1.2892 1.2892 1.2892 1.2992 1.2893 1.2893 1.2992 1.3123	.8949 .8728 .8728 .8460 .8315 .6211 .81 FEL .6042 1.6042 1.5035 1.4970 1.4970 1.4902 1.4902 1.4108 1.3706 1.9916 .9916 .9902 .9491 .8988 .8538 .8538	358 308 261 207 172 142 142 = 20·1 741 738 730 721 707 099 004 087 533 531 477 404 350 300	.00036 .00030 .00023 .00019 .00016 22, O/F .00137 .00132 .00124 .00141 .00114 .00094 .00096 .00096 .00097	3.877 4.331 4.990 5.541 6.144 = 3.968 0.000 .288 .599 .764 .900 1.108 1.604 2.145 2.529 2.940 2.940 2.940 3.427 3.837 4.275	498.2 447.6 457.6 463.6 468.5 257.9 354.6 316.4 307.9 332.6 367.7 389.9 408.4 428.2 450.1 466.6	16.y63 27.800 53.499 187.879 144.468 1.256 1.060 1.010 1.010 1.307 2.224 3.553 5.642 10.777 17.699 29.139	1.613 1.678 1.782 1.788 1.821 1.849 0.000 201 287 287 283 612 674 2740 1.401 1	417. 430. 444. 459. 0. 49. 95. 129. 124. 346. 347. 346. 347. 346. 401. 418. 432.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute; equilibrium composition during isentropic expansion

			,	,	,								
Pressure ratio, P _c /P	Static pressure, P, Ib/Igin.	Temp- erature T,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, μ, micro	Thermal conductivity,	Mach number M	Specific impulse in vacuum		Thrust coefficient	Specifi impuls I,
'c / '	obs	°K	(4)	אני	γ	(o)(°K)	poises	col/(sec) °KHcm	, ~	I _{vac,} (lb)(sec)/lb	3	C _F	(M)(sec)/
				R = 0.60	O, PERC	ENT FUEL	= 17.	35. J/F	= 4.76	2			•
1.00	300.00		5841.6	11.290	1.1529	1.9667	796	0.00174	0.000			0.000	0.
1.05	285.71 250.00	3137	5814.6	11.300	1.1532	1.9446	794	•00172	•291	543.6	2.140	• 200	48
1.40	214.29	3033	5741.6	11.326	1.1544	1.8842	787 780	•00166 •00±59	•565 •772	346.0	1.248	.384 .519	93.
1.60	187.50	2985	5588.7	11.378	1.1576	1.7545	773	•00152	.916	301.2	1.007	.611	148
1.75 2.00	171.73	2953	5543.1	11.393	1.1588	1.7154	768	•00149	1.000	300.2	1.000	•663	161
4.00	75.00	2652	5140.3		1.1743	1.6559	761 724	•00143 •00115	1.119	301.8 327.7	1.013 1.328	.736 1.017	178 247
10.00	30.00	2311	4749.0	11.583	1.1992	1.0984	667	•00088	2.144	364.3	2.303	1.269	308
20.00	15.00	2054	4489.8	11.606	1.2185	.9752	618	•00073	2.512	387.6	3.673	1.412	343
40.00	14.70 7.50	2047 1808	4482.6 4260.9	11.607	1.2190	•9726 •9053	616 565	•00073 •00063	2.522	388.2 407.2	3.726 5.977	1.416	343 370
			1			!				-	i		310
100.00 200.00	3.00 1.50	1512	4001.1 3834.0	11.616	1.2523	.8496 .8145	494	•00052 •00045	3.371	428.3 441.3	11.57d	1.647	400
400.00	• 75	1130	3689.5	11.616	1.2802	.7815	381	•00038	4.171	452.2	31.993	1.781	A32.
1000.00	• 30	919	3529.3	11.616	1.2993	.7427	312	•00030	4.757	463.8	62.803	1.847	448.
2000-00	• 15	782	3428.6	11.616	1.3126	.7183	265	•00025	5.244	470.9	104.524	1.886	458
4000.00	•08	661	3343.2	11.616	1.3242	•6988	223	•00020	5.776	476.8	173.763	1.919	466
		,		= 0.700	PERCE	NT FUEL	= 15 • 2	5. 0/F	= 5.556	,			
1.00	300.00 285.71	3307 3291	5138.3 5112.9	12.574	1.1378	2.3992	836	0+00217	0.000	5.47.4	3 100	0.000	9
1.20	250.00	3248	5044.0	12.568	. 1.1378 . 1.1379	2.3785	834	•00215 •00208	•293 •569	527.6 336.2	2.129	.198	90
1.40	214.29	3198	4966.0	12.667	1.1382	2.2512	621	+00201	.777	300.7	1.053	.517	122.
1.60	187.50 172.98	3156 3130	4859.9	12.702 12.723	1.1386	2.1898	815 811	•00194 •00190	1.000	293.1 292.3	1.006	•608	155
2.00	150.00	3085	4790.8	12.759	1.1395	2.0841	802	•00190	1.127	294.1	1.000	•657 •734	173
4.00	75.00	2865	4471.7	12.920	1.1454	1.7441	774	.00150	1.625	320.4	1.344	1.016	240
10.00	30.00	2569	4091.1	13.081	1.1620	1.3258	728	.00110	2.149	358.1	2.374	1.274	301.
20.00	15.00 14.70	2335	3833.6 3826.4	13.157	1.1511	1.0849	687	.00088	2.503	382.5	3.843	1.422	336
40.00	7.50	2095	3602.0	13.196	1.1317	1.0791 .9294	686	•00087 •00072	2.513	383.1 403.2	3.900 6.337	1.543	337
100.00	3.00	1785	3334.7	13.213	1.2246	.8253	573		J.312	425.6	12.441	i	396
200.00	1.50	1566	3160.2	13.216	1.2378	.7835	518	•00050	3.682	439.6	20.858	1.672	414
400.00	• 75	1368	3007.3	13.216	1.2508	•7>00	462	•00043	4.070	451-4	35.080	1.817	430.
1000.00	• 30	1133	2835.4	13.216	1.2690	•7094	389	•00035	4.616	464.2	69.841	1.889	447.
4000-00	•15 •08	975 834	2725.7 2631.6	13.216	1.2833	.6811 .6564	337	•00029	5.065	472.1	117.461	1.933	458.
-000-00	•00			13.216			288	•00024	5.551	478.7	197.192	1.971	467.
			R	- 0.800	PERCE	NT FUEL	= 13.6	0, 0/F	= 6 • 349				
1.00	300.00 285.71	3393 3378	4586.9 4563.0	13.740 13.757	1.1296	2.7921	864 861	0.00257	0.000	5 1 1 2	2 122	0.000	0.
1.20	250.00	3338	4498.3	13.803	1.1289	2.7382	856	•00255 •00250	•294 •571	511.3	2.123	.198	45 . 87 .
1.40	214.29	3292	4424.9	13.855	1.1284	2.6891	850	.00244	.780	291.8	1.052	.515.	110.
1.60	187.50 173.68	3253 3231	4362.3 4326.9	13.900	1.1281	2.6439	844	•00238 •00235	1.000	284.5	1.005	.607 .653	139.
2.00	150.00	3189	4259.9	13.974	1.1276	2.5628	835	•00229	1.131	285.6	1.015	.732	168.
4.00	75.00	2995	3957.6	14.193	1.1277	2.2689	007	•00197	1.632	312.0	1.354	1.016	234.
10.00	30.00	2744	3592.8	14.449	1.1332	1.8019	770	•00152	2.156	349.9	2.423	1.277	294.
20.00	15.00 14.70	2550 2544	3341.8	14.605	1.1439	1.4368	738	.00119 .00118	2.505	375.0 375.7	3.982	1.429	329.
40.00	7.50	2344	3111.8	14.716	1.1620	1.1265	702	•00091	2.832	396.7	6.676	1.433	330. 358.
100.00	3.00	2053	2840.4	14.791	1.1918	.8717	645	00067	3.260	420.6	13.365	1.692	389.
200.00	1.50	1830	2659.7	14.810	1.2106	.7805	595	•00067 •00056	3.601	435.6	22.652	1.778	409.
400.00	. 75	1617	2499.6	14.815	1.2246	.7331	541	•00049	3.964	448.3	38.453	1.850	426.
000.00	-30	1360	2316.9	14.816	1.2412	-6903	468	-00040	4.478	462.3	77.533	1.929	444.
000.00	•15 •08	1185	2198.7	14.816	1.2543	.6615 .6339	413 359	•00034 •00029	4.894 5.340	471.0	131.747	2.021	455. 465.
		102.								7,0.4	2231473	2.021	403.
						NT FUEL =	12.28	0/F	7 • 143				
1.00	300.00 285.71	3430 3416	4142.9	14.789	1.1261	2.9626	883	0.00276	0.000	495.7	2.121	0.000 198	0 • 44 •
1.20	250.00	3377	4059.8	14.861	1.1250	2.9343	875	•00273	•572	316.0	1.240	.381	85.
1.40	214.29	3334	3990.7	14.921	1.1242	2.9078	869	•00267	.781	282.9	1.051	.515	115.
1.60	187.50 173.98	3296 3276	3931.9		1.1235	2.8682	864	•00263 •00261	1.000	276.0	1.005	.606 .651	135.
2.00	150.00	3235	3835.4	15.058	1.1225	2.8374	855	•00257	1.133	277.1	1.016	.734	163.
4-00	75.00	3054	3550.3	15.317	1.1198	2.6636	829	•00234	1.635	303.0	1.358	1.016	227.
10.00	30.00	2629	3204.5	15.641	1.1165	2.3536	195	•00400	2.161	340.5	2.448	1.278	285.
20.00	15.00	2666	2964.3		1.1199	2.0547	769	•00170	2.511	365.6	4.058	1.432	320.
40.00	14.70 7.50	2661	2741.4		1.1200	1.7023	768 742	•00169 •00138	2.521	366.3	4.121 6.901	1.437	321.
				1		- 1			1		- 1	- 1	
200.00	3.00	2276	2472.2	16.364	1.1443	1.2030 .9125	700	•00095 •00070	3.241	413.0	14.187 24.518	1.706	381.
400.00	•75	1877	2121.5	16.403	1.1947	.7617	615	•00070 •00056	3.858	443.0	42.200	1.876	419
00.00	•30	1606	1928.5	16.415	1.2158		564						
000.00	•15	1416	1801.8	16.416	1.2158	.6840 .6520	546 491	•00046 •00039	4.329	458.2	86.184	2.019	439. 451.
00.00	•08	1241			1.2404	.6246	437		5.130	476.1	253.224	2.066	462.
	1			i									

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio.	Static pressure, P.	e. 0.0.0.e.		Molecular weight,	Isentropic exponent,		Viscos- ity, µ,	Thermal conductivity,	HOHIDER	Specific impulse in vacuum,		coefficient.	Specific impulse
P _c /P	lb√sqin. obs	T, K	col/g	900	γ	c _{p.}	micro poises	k, col/(secil ^o K) cm)	м	I _{voc.} (#bilsec)/#b	ε	C _f	I, dbiisec/di
	•				i nebco	NIT FILES	I. '	19, 0/F	. 7.92	L			,
		г -т		1			·	T		,			
1.00	300.00	3437	3777.9 3756.8	15.734	1.1250	2.8811	896 894	0.00272	0.000	481.0	2.120	0.000	
1.05	285.71 2>C.00	3384	3699.5	15.811	1.1239	2.0011	088	.00708	.572	306.7	1.239	.380	02 . t
1.40	214.29	3541	3634.5	15.875	1.1230	2.8421		.00261	.781	274.6	1.051	•515 •606	111.7
1.60	187.50 174.06	3304		15.93C 15.961	1.1222	2.8138	674	•00259	1.000	267.2	1.000	•651	141.3
2.00	150.00			16.023	1.1211	2.7914		•00256 •00237	1.635	269.0 294.2	1.016	1.016	158.6
4.0C	75.00	3065	3219.4	16.303	1.1179	2.6657	542	*002:1	1.033	2,74.2	1.000	14010	i
10.00	30.00		2893.0	16.659	1.1151	2.4459		•002.0	2.162	330.7 355.3	2.453 4.076		2/7•9
20.00	15.00 14.70	2692	2659.3	16.914	1.1142	2.2431	د ۱۵ د ۲۵	+001-7 +001-7	1.0266	355.0	4.140	1.438	314.0
40.00	7.50	2542	2454.2		1.1148	6.0143			2.840		6.959	1.564	334.4
100.00	3.00	2349	2196.7	17.439	1.1100	1.6031	124	+001 ∠	3.250	402.3	14.469	1.709	370 - 9
200.00	1.50	2203	2017.9	17.625	1.1200	1.4246	695	. •001 9	3.549	418.9	25.445	1.803	391.
400-00	.75	2052	1052.3	17.779	1.1500	1.1770	063	•000 /	3.045	433.7	44.925	1.580	409.
1000.00	• 30	1839	1653.8	17.920	1.1272	.8797	014		4.239		95.113	1.981	
2000-00		1668	1519.2	17.979	1.1821	.7520	>70 >20			461.4	166.750 290.406		455
4000.00		1493	L	i			ļ		·				
			F	R = 1.500	• PERCE	NT FUEL	= 7.	749, J/F	=11.90	5	_		
1.00		3297	2626.1		1.1288	1.8003		0.00177	0.000			0.000	0.
1.05	285.71 250.00		2609.6 2564.9	19.342	1.1286	1.7919	915	•00176 •00172	.294	425.1 271.0	2.123 1.241	.198	37.
1.40	214.29	3198	2514.1	19.468	1.1277	1.7391		•001:8	.780	242.6	1.052	.515	98.
1.60	187.50	3159	2470.9	19.526	1.12/3	1.7131	096 092	•001 3	1.000	230.6 230.9	1.005	•607 •653	116.
1.73 2.00	173•72 150•00	3127	2446.4	19.558	1.1269	1.6072	886	•001 9	1.131	237.5	1.015	.732	140-
4.00	75.00	2904	2190.9	19.900	1.1267	1.5076	854	•001 9	1.632	259.4	1.354	1.016	194.
10.00	30.00	2661	1938.5	20.228	1.1302	1.2677	812	•001 3	2.158	291.1	2.427	1.277	244.
20.00	15.00	2478	1764.5	20.435	1.1369	1.0774	179		2.508	312.1	3.997	1.429	273.
20.41 40.00	14.70 7.50	2472	1759.5	20.440	1.1372	1.0719 .8963			2.837		6.734		298.
40400	_			1			1		1		12 (1)		
100.00	3.00 1.50	2032	1413.9	20.734	1.1726	.7030 .6070	686 638				13.621 23.271	1.695	
200.00 400.00	.75	1629	1171.3	20.805		>>00			3.927	374.8	39.732	. 1.857	355.
	7.4	1379	1039.8	20.512	1.2325	.>072	513	+000-4	4.422	386.9	80.499	1.940	371.
2000-00	•30 •15	1207	954.3		1.2452	4650		•000 8	4.828	394.5	137.214	1.991	381.
4000.00	• 28		879.8	20.613	1.2584	.4650	402	•000 4	5.263	401.0	233.567	2.035	189.
		1		R = 2.00	D, PERCE	NT FUEL		927, U F	=15.87	3			
			1		·	1.2138	1	1	0.000		1	0.000	0.
1.00	300.00 285.71	3088	2016+0	21.743	1.1368	1.2052		•001 0	.293	388.8	2.129	• 198	34.
1.20	250.00	3046	1964.8	21.797	1.1370	1.1812			•>69 •777	247.8	1.243	.382	
1.40	214.29	2998	1922.4	21.857	1.1377	1.1528		•001 0	.922	216.1	1.006	. 608	106+
1.73	173.03	2932	1864.9	21.936	1.1380	1.1122	881 673		1.000	215.4	1.000		114.
2.00 4.00	150.00 75.00	2889	1653.8		1.1387	1.0844	035	•001 ib	1.026		1.344		177.
			i									1 .76	
10.00 20.00	30.00 15.00	2402	1446.7	22.451	1.1579	.7044			2.151	282.2	2.379	1.422	248.
20.41	14.70	2181	1302.4	22.569	1.1751	.6447	/35	•000 ->	2.515	202.7	3.918		249.
40.00	7.50	1970	1179.6	22.633	1.1945	.5611	557	•000 6	2.846	297.7	6.365	1.544	269.
100.00	3.00	1686	1032.8	22.568		•4923	616		3.304		12.580		292.
200.00	1.50	1483	936.7 852.3	22.675	1.2341	.4632 .4427	559				21.125		306.
400.00	• 75	1297	852.3	22.011	1.24/0	.4421	707	• 000 .6	4.055	233.1			
1000.00	•30	1076	757.2		1.2636	.4201		• 000 13	4.596	343.4	70.973	1.894	331.
4000.00	•15 •0d	797	696.4	22.677		•4046 •3900		•000:0	5.518	349.3	201.392		345.
			i	1	<u> </u>			1		1	l	1	1 .
				R = 3.00				031, O F			т.	·	
1.00	300+00	2723	1381.4	24.669	1.1539	0.6909	865		0.000		2.146	0.000	
1.05 1.20	285•71 250•00	. 270>	1370.7	24.002	1.1040	.6659	854		.563	217.5	1.252	.385	58.
1.40	214.29	2604	1309.3	24.751	1.1694	+6451	841	• 000 +3	• 768	194.0	1.058	.521	79.
1.60	187.50	2556	1281.7	24.780		.6275 .6155				188.9	1.008		101.
1.76 2.00	170.82		1236.7	24.823	1.1766	.5991	816	+000>7	1.114	189.1	1.012	. 738	112.
4.00	75.00	2232	1106.3	24.922	1.1938	.5216	764	•000+7	1.609	204.8	1.317	1.018	254.
10.00	30.00	1914	955.2		1.2185	.4517	690	-00018	2.144	227.0			
20.00	15.00	1684	856.1	25.002	1.2347	.4206	632	+00013	2.521	241.0	3.584		
20.41 40.00	14.70 7.50		853.3 769.2			.4199 .4007			2.532	241.4	5.802		
-0.00	1		1							İ			
	3.00					.3613			3.403		11.177	1.635	
100.00			608.7	25.008	1 102/24						30.718	1.764	
200.00	1.50				1.2577	.3557	393	-00CTR	4.222	279.9	20.110	1.104	
200.00 400.00	1.50 .75	906	554.8	25.008	1.2877	.3557	1		1				İ
200.00	1.50 .75	906 735		25.008	1.2677	.3557	050	•00014 •00012	4.823	286.8 291.1	60.154	1.826	217.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Concluded. Combustion-chamber pressure, 300 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio, P _C /P	Static pressure, P, Ib/sqin obs	Temp- erature, T, "K	Enthalpy, h, cai/g	Molecular weight,	Isentropic exponent,	Specific heat, c _{p.} col/(g)(°K)*	Viscos- ity, #, micro poises	Thermal conductivity, k, cal/isecK ^a Kiicm	Mach number M	Specific impulse in vacuum, I vac. 	Area ratio, €	Thrust coefficient,	Specific impulse I, ibiiwci/ii
				R = 4.000	PERCE	NT FUEL	= 3•	054, O/F	=31.74	6			
1.00 1.05 1.20	300.00 285.71 250.00	2372 2354 2303	1045.7	26.307 26.312 26.327	1.1993 1.2005	0.4836 .4796 .4089	804 800 789	0.00046 .00046 .00044	. 255	308.5 195.6	2.172 1.202	. 390	27.
1.40		2244	995.8	26.341	1.2000		776 765	00043	.757 .899		1.053		71.
1.78	168.42	2153	955.8	26.360	1.2.45	.4412	155	•00040	1.000	168.9	1.000	. 582	92.
2.00 4.00	150.00 75.00	2110 1859	937.2 833.7	26.367	1.21/3	•4341 •4010	745 685		1.100	169.5	1.294		
10.00	30.00	1555	716.2	26.404	1.2517	.3749	605	-00028	2.149	201.2	2.184		
20.00	15.00 14.70	1349 1343	640.5 638.5	26.406	1.2631	.3614	547 545	•00025 •00025	2.541	213.0	3.426	1.397	189.
40.00	7.50	1165	575.1	26.406	1.2740	.3499	491	•00022	2.930	222.9	5.499		
100.00	3.00	952 813	502.2	26.406	1.2895 1.3021	.3352 .3243	421 372	.00018 .00016	3.457	233.4 239.8	10.472 17.179	1.614	219.
200.00 400.00	1.50 .75	690	456.3 417.1		1.3153		325	•00013			28.266		
.000.00	•30	552	374.5		1.3331			•00011	4.957	250 • 7		1.791	243.
000.00	•15 •08	463 386	348.0 326.0		· 1•3459 . 1•3564	.2928 .2864	232 197	•00009 •00007		∠54.0 ∠56.8	89.984 147.985	1.825	247. 251.
			F	₹ = 5+000), PERCE	NT FUEL	= 2 • 4	458, U/F	=39.68		L	A	•
1.00	300.00		855.0		1.2295	0.3968	742		0.000			0.000	
1.05	285.71 250.00	2051	847.7 828.0	27.315	1.2306	.3947 .3893	737	•00036	•282 •548	282.5 179.1 159.4	2.189		25 • 48 •
1.40	214.29	1942	805.9	27.324	1.2371	.3835	711 699	•00034	•749	154.8	1.066		65. 76.
1.60	187.50 166.83	1893 1851	771.4	27.327 27.329	1.2424	•3790 •3753	689	•00033 •00032	1.000	153.9	1.000	•691	85.
2.00	150•00 75•00	1813 1578	757.2 671.9		1.2445	•3722 •3564		•00031 •00028	1.594		1.007		
10.00	30.00	1303	576.1	27.339	1.2709	•3411		•00023	2.152		2.143	1.202	155.
20.00	15.00 14.70	1122	515.1 513.5	27.339 27.339	1.2815	•3109 •3106	484 482	•00040	2.550 2.562	192.5	3.342	1.390	172.
40.00	7.50	961	462.8	27.339	1.2929	+3209	434	•00018	2.947	201.2	5.550	1.496	184.
100.00 200.00 400.00	3.00 1.50 .75	777 658 554	368.9	27.339 27.339 27.339	1.3095 1.3227 1.3364	.3076 .2979 .2887	367 321 279	•00015 •00012 •00011	3.487 3.919 4.380	210.3 215.8 220.3	10.066 16.399 26.792	1.666	205. 212.
000.00	•30 •15	438 365 303	285.3	27.339 27.339 27.339	1.3536 1.3533 1.3097	•2782 •2728 •2693	229 195 164	•00008 •00007	5.049 5.613	225.0 227.8 230.1	51.338 83.976 137.439	1.603	222.
000.00	•08		200.0	1 274333	113071	1. •2075	107	1		13011	1314437	1	
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TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXY3EN

(d) Combustion-chamber pressure, 600 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, µ,	Thermal conductivity.	(1011)	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	Specifi impuls
P _e /P	No/sqin. abs	T, °K	(al/g	900	γ	col/(g)(°K)`	micro poises	k, cal/(sec)(°K)(cm	M	I voc.	ε	C,	L (B)(sec)/
				R = 0.150	DEPCE	NT FUEL		L	= 1.19		<u> </u>	L	1
										Ī			
1.00	600.00 571.43	1183	5313.5 5287.7	4.416 4.416	1.3396	1.7753	314 311	0.00073 .00073	0.000 .271	530-0	2.250	0.000	47
1.20	500.00	1129	5218.6	4.416	1.3436	1.7597	303	-00070	.527	334.2	1.297	.403	90
1.40	428.57 375.00	1085	5141.8 5077.7	4.416 4.416	1.3469	1.7472	293 285	•00068 •00066	•722 •860	296.1 286.6	1.081	.543 .636	122
1.87	321.68	1008	5006.8	4.416	1.3>28	1.7256	276	•00063	1.000	284.1	1.000	.725	163
2.00 4.00	300.00 150.00	989 824	4975.4	4.416 4.416	1.3541	1.7210	272 234	•00062 •00052	1.059	284.4	1.003 1.233	1.031	171 232
		643	4392.5	4.416	1.3748	1.6506	188	•00042	2.152	327.5	1.974	1.257	283
20.00	60.00 30.00	532	4209.8	4-416	1.3799	1.6345	159	+00035	2.586	343.5	2,983	1.376	309
40.00	15.00 14.70	439 437	4058.9 4054.8	4.416 4.416	1.3824	1.6269	133	+00029 +00029	3.031 3.044	356.4 356.8	4.620	1.467	330 330
100.00	6.00	340	3899.0	4.416	1.3883	1.6089	104	-00023	3.648	369.8	8.432	1.558	350
200.00 400.00	3.00 1.50	280 230	3802.5 3723.2	4.416 4.416	1.3930	1.5951	25 70	.00018 .00015	4-148	377.7 384.1	13.431 21.488	1.610	362 372
								:					
2000.00	•60 •30	175 142	3640.1 3590.9	4.416	1.4347	1.4852	55 45	•00011 •00009	5.438	390.6	39.928 63.572	1.694	381 387
4000.00	•15	114	3551.2	4-416	1.4717	1.4039	36	•00007	6.842	397.3	100.938	1.739	391
	· · · · · · · · · · · · · · · · · · ·		R	= 0.200	, PERCE	NT FUEL	= 38 • 6	5, 0/F	= 1.58	? ,			
1.00	600.00 571.43	1514	2969.7 2941.7	5.216 5.216	1.3078	1.6187	402 399	0.00084	0.000 .274	552.1	2.233	0.000 .209	49
1.20	500.00	1450	2866.8	5+216	1.3119	1.6024	389	•00081	.533	348.6	1.289	+400	94
1.40	428.57	1398	2783.1	5.216	1.3154	1.5888	378	•00078 •00076	•730	309.3	1.077	.539	127
1.60	375.00 324.94	1354	2713.2	5.216 5.216	1.3185	1.5773	369 359	•00076 •00073	.869 1.000	299.6	1.016	.632 .716	169
2.00	300.00	1282	2601.1	5.216	1.3236	1.5584	353	•00072	1.068	297.8 316.7	1-004	• 757	179
4.00		1079	2290+0	5.216	1.3391	1.5046	307	•00061	1.572		1.244	1.029	243
20.00	60.00 30.00	852 709	1954.3 1748.8	5.216 5.216	1.3558	1.4516	251	.00048 .00040	2.148 2.573	362.0	2.009 3.049	1.257	297 325
40.00	15.00	588	1578.0	5.216	1.3715	1.4066	179	•00034	3.010	376.0	4.739	1.472	348
40.83	14.70	585	1573.4	5.216	1.3716	1.4062	178	+00034	3.023	376.4	4.802	1.474	348
100.00	5.00 3.00	458 379	1396.3 1285.1	5.216 5.216	1.3770	1.3916	142	•00026 •00022	3.619 4.111	390.5	8.679 13.870	1.565	370 382
400.00	1.50	312	1195.2	5.216	1.3858	1.3684	96	•00018	4.638	406.1	22.296	1.662	393
1000.00	•60	242	1098.9	5.216	1.3972	1.3402	74	+00013	5.394	413.4	41.979	1.706	403
2000-00	•30	198	1041.1	5.216	1.4157	1.2976	61	•00011	6.014	417.7	67.687	1.733	409
+000.00	•15	161	993.9	5.216	1.4362	1.2543	50	+00009	6.701	421.1	108.754	1.754	414
				- 0-250		NT FUEL			× 1.984				
1.00	600.00 571.43	1817 1797	1249.3 1220.2	6.016 6.016	1.2827	1.4998	481 477	0.00092 .00091	0.000	563.4	2.218	0.000 207	50
1.20	500.00	1745	1142.1	6.016	1.2865	1.4840	467 456	•00089 •00086	•538 •736	356.2	1.283	•398 •536	96 130
1.40	428.57 375.00	1686	1054.•7 981.•5	6.016 6.016	1.2924	1.4604	446	•00084	.876	306.6	1.015	-629	152
1.83	327.81	1587	909.9	6.016	1.2952	1.4494	436	•00081	1.000	304.5	1.000	+708	171
2.00 4.00	300.00 150.00	1555	863.9 535.1	6.016	1.2971	1.4423	429 378	•00080 •00068	1.578	305•1 325•5	1.005 1.256	.754 1.027	183 249
10.00	60.00	1057	176.1	6-016	1.3329	1.3225	514	•00054	2.147	355.3	2.048	1.258	305
20.00	30.00	887 741	9954.0	6.016	1.3568	1.2849	269 228	•00046 •00038	2.563	373.7 388.7	3.127 4.883	1.382	335 359
40.00 40.83	15.00 14.70	737	9763.1	6.016 5.016	1.3571	1.2552	227	•00038	3.000	389.1	4.949	1.481	359
100.00	6.00	581	9569.0	6.016	1.3663	1.2321	181	•00030	3.581	404+2	8.985	1.575	382
200.00	3.00 1.50	482 399	9447.8	6.016 6.016	1.3717	1.2189	151 125	•00025 •00020	4.064 4.582	413.4 420.9	14.396 23.208	1.630	395 406
					1.3820	1.1949	95	.00015	5.327	428.7	43.893	1.722	418
2000-00	•60 •30	310 256	9240.5 9175.9	6.016	1.3883	1.1810	78	.00012	5.945	433.4	71.279	1.749	424
•000•00	•15	210	9122.7	6.016	1.4037	1.1485	64	•00010	6 • 6 0 6	437.2	115.650	1.771	430
·				= 0.300		NT FUEL			- 2.381		-		
1.00	600+00 571+43	2094	9932.7	6.815	1.2613	1.4145	551 547	0.00098	0.000 -279	568.6	2.206	0+000 +206	0 50
1.20	500.00	2016	9823.5	6.815	1.2650	1.3967	537	•00095	.542	359.8	1.277	.396	97
1.40	428+57	1952	9734.3	6.815	1.2661	1.3825	525	•00092	•742	319.8	1.071	.533	131
1.60	375.00 330.21	1898	9659.4	6.816 6.816	1.2708	1.3706	515 505	.00089 .00087	.882 1.000	310.3	1.013	.626 .701	172
2.00	300.00	1809	9538.8	6.816	1.2753	1.3519	498	•00085	1.082	309.1	1.006	.751	185
4.00	150.00	1553	9199.6	6.816	1.2894	1.2991	445	•00074	1.585	330.6	1.266	1.025	252
10.00	60.00	1257	8825.3 8591.1	6.816 6.816	1.3095	1.2336	375 325	•00060 •00051	2.148	361.8 381.2	2.085 3.206	1.260	310
20.00 40.83	30-00 14-70	1064 891	8591.1	6.816	1.3248	1.1522	277	*00051 *00042	2.981	397.4	5.106	1.486	366
40.00	15.00	895	8393.6	6.816	1.3384	1.1531	279	•00042	2.968	397.0	5.037	1.485	366
100.00	6.00	707	8180.3	6.816	1.3530	1.1174	223	•00033	3.544	413.5	9.324	1.585	390
200.00	3.00 1.50	590 490	8049.6 7940.8	6.816	1.3603	1.1007	187 156	•00027 •00023	4.013 4.517	423.3	14.993 24.234	1.643	404
~00.00	1.00				i				5.247				
					1.3723 :			•00017	4-147	439.6	45.999	1.738	428
1000.00	•60 •30	383 317	7824.8 7754.3	6.816	1.3775	1.0746	120 98	.00014	5.852	444.6	74.912	1.767	435

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(d) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature	Enthalpy,	Molecular weight,	Isentropic exponent,		Viscos ity, µ,	Thermal conductivity,	Moch number	Specific impulse	Area ratio,	Thrust coefficient	Spec
P _c /P	ib/sqin.	Ť, °K	col/g	2002	γ	c _{p.}	micro	k, cal/[sec](°K)(cm)	M	in vacuum	rα110, ε	C _F	I Ibitses
	OE 1	L	1	1		•	poises	1	L	(lb)(sec)/lb	l	<u>L</u>	ii IID II sec
		,		R = 0.35), PERCI	ENT FUEL	= 26+	47, O/F	= 2.77	•			
1.00	600-00		8892.8	7.610	1.2410		611	0.00104	0.000		i	0.000	
1.05	571.43	2325	8863.0	7-610	1.2421		608	.00103	-281	5/0.0	2.195	• 205	5
1.20	500.00 428.57	2266 2198	8783.0 8693.2	7.611 7.613	1.2451	1.3440	598 586	-00100	•546	361.0	1.273	. 394	9
1.60	375.00	2140	8617.6	7.613	1.2513		576	•00097 •00094	•747 •887	321.2 311.8	1.068	+531	13
1.81	332.36	2089	8551.0	7.614	1.2538	1.2974	567	00092	1.000	310.0	1.002	+623 +695	15
2.00	300.00	2046	8495.7	7.614	1.2559	1.2874	559	.00090	1.488	310.9	1.007	.749	10
4.00	150.00	1771	8150.9	7.616	1.2699	1.2291	506	•00079	1.590	333.2	1.275	1.023	25
10.00	60.00	1451	7766.6	7.616	1.2885	1.1655	434	+00065	2.149	365.6	2+119	,	31
20.00	30.00	1238	7523.9	7.616	1.3036	1.1204	381	•00055	2.550	385.8	3.281	1.390	34
40.83	14.70	1045	7311.7	7.616	1.3192	1.0783	328	+00046	2.765	402.9	5.260	1.494	37
40.00	15+00	1050	7317.3	7.616	1.3188	1.0794	330	-00046	2.753	402.5	5.188	1.491	37
100.00	6.00	838	7092.4	7.616	1.3364	1.0365	267	•00036	3.511	419.8	9.6/6	1.594	34
200.00	3.00	702	6953.5	7.616	1.3475	1.0118	225	•00030	3.964	430-2	12.020	1.624	41
400.00	1.50	586	6837.3	7.616	1.3553	.9953	188	•00025	4+453	438.6	25+350	1.703	43
1000.00	•60	460	6712.8	7 414	3 3434	0700							
2000.00	•30	382	6636.9	7.616 7.616	1.3634	•9789 •9692	148 121	•00019 •00016	5 • 1 • 2 5 • 7 5 1	447.05	48 • 288 78 • 852	1.754	43
4000.00	•15	317	6573.8	7.616	1.3738	•9590	98	•00013	6.392	457.2	128+949	1.809	44
			F	= 0.400	• PERCE	NT FUEL	■ 23·5	5 0/F	■ 3+175				
1.00	600.00	2574	8050-5	8.396	1.2209	1.3697	663	0.00110	0.000			0.000	
1.05	571.43	2552	8020.9	8.397	1.2220	1.3599	660	•00109	.283	568.5	2.184	+204	5
1.40	500.00 428.57	2492 2422	7941.2 7851.7	8.401 8.404	1.2252	1.3344	650	•00106	•550	360.5	1.208	. 192	9
1.60	375.00	2363	7776.1	8.406	1.2289	1.3072	639 630	•00102 •00100	• 752 • 895	321.0 311.6	1.065	4528	13
1.79	334+53	2313	7713.0	8.408	1.2347	1.2685	621	•00097	1.000	310.2	1.001	•621 •6#8	17
2.00	300.00	2266	7654.1	8.410	1.2372	1.2533	613	•00095	1.094	311.2	1.008	-746	18
4.00	150.00	1978	7306.9	8.414	1.2520	1.1787	561	-00083	1.594	334.3	1.284	1.022	25
10.00	60.00	1637	6916.6	8.416	1.2701	1.1109	489	•00069	2+149	367.6	2 • 150	1.262	31
20.00	30.00	1408	6667.8	8.416	1.2842	1.0669	434	• 08059	2+545	388 • 6	3.351	1.393	344
40.00 40.83	15.00 14.70	1204 1199	6454.3	8.416 8.416	1.2996	1.0253	380	•00050	2.940	405.9	5.334	1.497	37
40003	14070	11,,,	0440.5	01410	142770	1.02-2	379	•00050	2.751	400.5	5.409	1.500	37
100.00	6.00	970	6219.8	8.416	1.3188	.9767	313	.00040	3.482	424.1	10.029	1.603	399
200.00 400.00	3.00	818	6073.7	8.416	1.3318	•9478	266	.00033	3.920	435.0	16.282	1.666	414
400.00	1.50	687	5950.8	8.416	1.3428	•9249	224	•00027	4.391	443.9	26.525	1.717	42
1000.00	•60	542	5818.5	8.416	1.3537	+9037	176	-00021	5.076	453.3	50.761	1.770	441
000.00	•30 •15	452 376	5737.3 5669.9	8.416 8.416	1.3595	∙8928	146	•00017	5 - 648	459.0	83 - 105	1.802	444
***************************************		310	L		1.3647	•8635	119	•00014	6.271	463.6	136.261	1.828	455
			R	- 0.450	• PERCE	NT FUEL	= 21+8	7. O/F	= 3.571				
1.00	600.00	2773	7354.5	9.167	1.2018	1.4156	707	0.00119	0.000		. 1	0.000	
1.05	571.43	2752	7325.3	9.170	1.2029	1.4027	704	.00118	•285	565.0	2.172	-203	50
1.20	500.00	2692	7246.5	9.177	1.2060	1.3686	695	.00114	+554	358.6	1.263	• 390	96
1.40	428.57 375.00	2624 2565	7157.9 7082.9	9.184 9.189	1.2097	1.3318	685 676	-00110	•757	319.6	1.063	•526	130
1.78	336.72	2517	7023.8	9.193	1.2154	1.2799	669	+00106 +00104	.899 1.000	310.7	1.010	.618	153
2.00	300.00	2467	6961.6	9.197	1.2183	1.2573	661	•00101	1.100	310.3	1.000	•682 •743	164
4.00	150.00	2174		9.210		1.1514			1.599	334.2			253
10.00	i		6614.5		1.2347	101017	611	•90087	40777		1.293	1.020	
	40.001	1017		0 000	1	l [ĺ	ļ			1.020	
	60.00 30.00	1817 1575	6220.9	9.215 9.216	1.2537	1.0682	540	•00072	2 • 149	368.3	2.182	1.020	
20.00 40.00	60.00 30.00 15.00	1817 1575 1357		9.215 9.216 9.216	1	l [•0 00 72 •0 0 063	2 · 149 2 · 539	389.9	2.182 3.420	1.020 1.263 1.397	34
20.00	30.00	1575	6220.9 5967.7	9-216	1.2537 1.2670	1.0682 1.0237	540 485	•00072	2 • 149		2.182	1.020	347 373
20.00 40.00 40.83	30.00 15.00 14.70	1575 1357 1350	6220.9 5967.7 5749.0 5743.0	9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815	1.0682 1.0237 .9828 .9816	540 485 429 428	•00072 •00063 •00054 •00054	2.149 2.539 2.927 2.939	389.9 407.8 408.3	2+182 3+420 5+4/6 5+554	1.020 1.263 1.397 1.503 1.506	347 374
20.00 40.00 40.83	30.00 15.00 14.70 6.00 3.00	1575 1357 1350 1104 937	6220.9 5967.7 5749.0	9.216 9.216	1.2537 1.2670 1.2811	1.0682 1.0237 .9828	540 485 429	.00072 .09063 .00054 .00054	2.149 2.539 2.927 2.939 3.455	389.9 407.8 408.3	2.182 3.420 5.476 5.554	1.020 1.263 1.397 1.503 1.506	341 373 374
20.00 40.00 40.83 100.00 200.00	30.00 15.00 14.70 6.00	1575 1357 1350 1104	6220.9 5967.7 5749.0 5743.0	9.216 9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815	1.0682 1.0237 .9828 .9816	540 485 429 428	•00072 •00063 •00054 •00054	2.149 2.539 2.927 2.939	389.9 407.8 408.3	2+182 3+420 5+4/6 5+554	1.020 1.263 1.397 1.503 1.506	341 373 374 401 41
20.00 40.00 40.83 100.00 200.00 400.00	30.00 15.00 14.70 6.00 3.00 1.50	1575 1357 1350 1104 937 792	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4	9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727	540 485 429 428 358 307 261	.00072 .00063 .00054 .00054 .00054	2.149 2.539 2.927 2.939 3.455 3.879 4.334	389+9 407+8 408+3 426+8 438+3 447+7	2.182 3.420 5.476 5.554 10.381 16.950 27.755	1.020 1.263 1.397 1.503 1.506 1.612 1.678 1.731	347 374 374 401 417 430
20.00 40.00 40.83 100.00 200.00 400.00	30.00 15.00 14.70 6.00 3.00 1.50	1575 1357 1350 1104 937 792 629	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4	9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3418	1.0682 1.0682 1.06837 .9828 .9816 .9325 .8996 .8727	540 485 429 428 358 307 261	.00072 .00054 .00054 .00054 .00036 .00030	2.149 2.539 2.927 2.939 3.455 3.879 4.334	389.9 407.8 408.3 426.8 438.3 447.7 457.6	2.182 3.420 5.476 5.554 10.381 16.950 27.755	1.020 1.263 1.397 1.503 1.506 1.612 1.678 1.731	341 373 374 401 414 430
20.00 40.00 40.83 100.00 200.00 400.00	30.00 15.00 14.70 6.00 3.00 1.50	1575 1357 1350 1104 937 792	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4	9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727	540 485 429 428 358 307 261	.00072 .00063 .00054 .00054 .00054	2.149 2.539 2.927 2.939 3.455 3.879 4.334	389+9 407+8 408+3 426+8 438+3 447+7	2.182 3.420 5.476 5.554 10.381 16.950 27.755	1.020 1.263 1.397 1.503 1.506 1.612 1.678 1.731	34: 37: 37: 40: 41: 43: 44: 45:
20.00 40.00 40.83 100.00 200.00 400.00	30.00 15.00 14.70 6.00 3.00 1.50	1575 1357 1350 1104 937 792 629 526	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3418 1.3502 1.3562	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727	540 485 429 428 358 307 261 207 172 142	.00072 .00063 .00054 .00054 .00036 .00030 .00030 .00023 .00019	2.149 2.539 2.927 2.939 3.455 3.879 4.334 4.994 5.544	389.9 407.8 408.3 426.8 438.3 447.7 457.6 463.6	2-182 3-420 5-476 5-554 10-381 16-950 27-755 53-398 87-714	1.020 1.263 1.397 1.503 1.506 1.612 1.678 1.731	347 373 374 401 416 430 444
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 000.00	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15	1575 1357 1350 1104 937 792 629 526 439	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3418 1.3502 1.3562	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL	540 485 429 428 358 307 261 207 172 142 = 20+1	.00072 .00063 .00054 .00054 .00054 .00030 .00030 .00023 .00019 .00016	2+149 2+539 2+927 2+939 3+455 3+879 4+334 4+994 5+544 6-148 3+968 0-400	389.9 407.8 408.3 426.8 438.3 447.7 457.6 463.6 468.5	2-182 3-420 5-476 5-554 10-381 16-950 27-755 53-398 87-714 144-197	1.020 1.263 1.397 1.503 1.506 1.612 1.66/8 1.731 1.787 1.820 1.848	341 373 374 401 430 444 452 459
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 000.00	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15	1575 1357 1350 1104 937 792 629 526 439	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2611 1.2815 1.3008 1.3152 1.3282 1.3282 1.3502 1.3562 PERCE!	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL	540 485 429 428 358 307 261 207 172 142 = 20-1	.00072 .09063 .00054 .00054 .00054 .00030 .00030 .00030 .00019 .00016 2. O/F	2.149 2.539 2.927 2.939 3.455 3.879 4.334 4.994 5.544 6.148 3.968 0.000 .287	389.9 407.8 408.3 426.8 438.3 447.7 457.6 463.6 468.5	2-162 3-420 5-476 5-554 10-381 16-950 27-755 53-396 87-714 144-197	1.020 1.263 1.397 1.503 1.506 1.612 1.6787 1.820 1.848 0.006 .202	341 373 374 401 430 444 452 459
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 000.00 1.00 1	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.919 9.923 9.935	1.2537 1.2670 1.2811 1.2811 1.2615 1.3008 1.3152 1.3282 1.3418 1.3502 1.3562 1.3562	1.0682 1.0237 .99828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL 1.5012 1.4856 1.4440	540 485 429 428 358 307 261 207 172 142 = 20-1	.00072 .00063 .00054 .00054 .00054 .00030 .00030 .00023 .00019 .00016 .000130 .000130 .000129	2-149 2-539 2-927 2-939 3-455 3-879 4-334 4-994 5-544 6-148 3-968 0-000 -287 -558	389.9 407.8 408.3 426.8 438.3 447.7 457.6 463.6 468.5	2-162 3-420 5-4/6 5-554 10-381 16-950 27-755 53-398 87-/14 144-19/	1.020 1.263 1.397 1.503 1.506 1.612 1.6787 1.820 1.848 0.006 .202 .388	341 373 374 401 430 444 452 459
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 000.00 1.00 1	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216	1.2537 1.2670 1.2611 1.2815 1.3008 1.3152 1.3282 1.3282 1.3502 1.3562 PERCE!	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL	540 485 429 428 358 307 261 207 172 142 = 20-1	.00072 .09063 .00054 .00054 .00054 .00030 .00030 .00030 .00019 .00016 2. O/F	2.149 2.539 2.927 2.939 3.455 3.879 4.334 4.994 5.544 6.148 3.968 0.000 .287	389.9 407.8 408.3 426.8 438.3 447.7 457.6 463.6 468.5	2-162 3-420 5-4/6 5-554 10-381 16-950 27-755 53-398 87-/14 144-19/	1.020 1.263 1.397 1.503 1.506 1.612 1.678 1.731 1.787 1.820 1.848	341 373 374 401 430 444 452 459
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 1.00 1.00 1.40 1.4	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 6741.0 6663.6 6576.3 6502.4 6447.5	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.219 9.923 9.935 9.937 9.957	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3502 1.3502 1.3502 1.3502 1.1849 1.1835 1.1917 1.1946 1.1917	1.0682 1.0237 .9825 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL 1.5012 1.4440 1.3979 1.3500	540 485 429 428 358 307 261 207 172 142 = 20•1 745 742 734 716 710	.00072 .00063 .00054 .00054 .00036 .00030 .00019 .00019 .000129 .00129 .00129 .00119 .00119 .00119	2-149 2-539 2-927 2-939 3-455 3-879 4-334 4-994 5-544 6-148 3-968 0-000 -287 -558 -762 -900	989-9 407-8 408-3 426-8 438-3 447-7 457-6 463-6 468-5 559-8 355-7 317-3 308-6 307-3	2-182 3-820 5-655 5-554 10-381 16-950 27-755 53-398 67-714 144-197	1.020 1.263 1.397 1.503 1.506 1.612 1.6787 1.820 1.848 0.000 0.000 0.202 0.388 0.588 0.666	314 347 373 374 401 430 444 452 459 0 129 152 167
20.00 40.00 40.80 100.00 200.00 400.00 000.00 000.00 1.05 1.20 1.40 1.60 1.77 2.00	30.00 15.00 14.70 6.00 3.00 1.50 .00 .30 .15 600.00 571.43 500.00 428.57 375.00 338.88 300.00	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2647	6220.9 9967.7 3749.0 5506.6 5354.4 5225.4 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6382.5	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-219 9-919 9-923 9-957 9-957 9-957 9-953	1.2537 1.2670 1.2811 1.2815 1.308 1.3152 1.3282 1.3418 1.3502 1.3562 1.3562 1.1849 1.1855 1.1855 1.1946 1.1970	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL 1.5012 1.4856 1.4440 1.3379 1.3500 1.3324	540 485 429 428 358 307 261 207 172 142 = 20•1. 745 742 734 716 710 702	.00072 .00063 .00054 .00054 .00036 .00030 .00030 .00019 .00016 .00129 .00129 .00115 .00115	2-149 2-539 2-927 2-939 3-459 3-879 4-334 4-994 5-544 6-148 3-968 0-000 -287 -502 -904 1-006	989-9 407-8 408-3 426-8 438-9 447-7 457-6 463-6 468-5 559-8 355-7 311-3 308-6 307-3 308-6	2-182 3-920 3-920 3-926 5-529 10-381 16-920 27-725 53-398 87-714 144-127	1.020 1.263 1.503 1.503 1.503 1.503 1.612 1.673 1.820 1.848 0.006 .202 .388 .524 .524 .616 .676	347 373 374 401 430 444 452 459 0 129 167 183
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 1.05 1.20 1.40 1.60 1.77 2.00 4.00	30.00 15.00 14.70 6.00 3.00 1.50 .30 .15 600.00 571.43 500.00 428.57 375.00 338.88 300.00 150.00	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356	6220.9 9967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6570.4 6477.5 6382.5 6037.6	9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.216 9.219 9.923 9.935 9.937 9.957	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3502 1.3502 1.3502 1.3502 1.1849 1.1835 1.1917 1.1946 1.1917	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL 1.5012 1.4440 1.3979 1.3500	540 485 429 428 358 307 261 207 172 142 = 20•1 745 742 734 716 710	.00072 .00063 .00054 .00054 .00036 .00030 .00019 .00019 .000129 .00129 .00129 .00119 .00119 .00119	2-149 2-539 2-927 2-939 3-455 3-879 4-334 4-994 5-544 6-148 3-968 0-000 -287 -558 -762 -900	989-9 407-8 408-3 426-8 438-3 447-7 457-6 463-6 468-5 559-8 355-7 317-3 308-6 307-3	2-182 3-820 5-655 5-554 10-381 16-950 27-755 53-398 67-714 144-197	1.020 1.263 1.397 1.503 1.506 1.612 1.6787 1.820 1.848 0.000 0.000 0.202 0.388 0.588 0.666	347 373 374 401 430 444 452 459 0 129 167 183
20-00 40-00 40-83 100-00 200-00 400-00 000-00 1-00 1-00 1-40 1-77 2-00 4-00 1-00	30.00 15.00 14.70 6.00 3.00 1.50 60 571.43 500.00 28.57 375.00 338.88 300.00 150.00 60.00	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6382.5 6037.6 5642.7	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-29 9-923 9-935 9-947 9-963 9-971 9-999	1.2537 1.2670 1.2811 1.2811 1.308 1.3152 1.3282 1.3418 1.3562 1.3562 1.3562 1.1859 1.1859 1.1859 1.1817 1.1917 1.1917 1.1919 1.1917 1.1919 1.1979	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 .8210 .8313 .8210 .8313 .8210 .8313 .8310 .8313 .8310 .8313 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .8313 .8310 .831	540 485 429 428 358 307 261 207 172 142 = 20•1. 745 742 734 716 710 702 655	.00072 .00063 .00054 .00054 .00036 .00036 .00019 .00019 .00019 .000129 .00129 .00129 .00129 .00129 .00129 .00129	2-149 2-539 2-927 2-939 3-455 3-879 4-334 6-148 3-968 0-000 -287 -752 904 1-000 1-100 1-603 2-147	989-9 407-8 408-3 426-8 438-3 447-7 457-6 463-6 468-5 559-8 305-6 308-6 308-6 333-1 368-0	2-182 3-920 3-920 3-926 5-529 10-381 16-920 27-725 53-398 87-714 144-127	1.020 1.263 1.503 1.503 1.503 1.503 1.612 1.673 1.820 1.848 0.006 .202 .388 .524 .524 .616 .676	3473 373 374 401 430 444 452 459 1292 167 183 252 313
20.00 40.00 40.83 100.00 200.00 400.00 000.00 000.00 1.00 1.05 1.20 1.40 1.60 1.77 2.00 4.00	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .60 .60 .60 .60 .60 .60 .60 .60 .60	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6037.6 5642.7 5386.6	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-919 9-923 9-995 9-997 9-997 9-999 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-9 9	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3282 1.3562 1.3562 1.3562 1.1849 1.1859 1.1859 1.1859 1.1946 1.1979 1.1998 1.2169	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL .1.4856 1.4440 1.3979 1.3600 1.3979 1.3008 1.1551	540 485 429 428 358 307 261 207 172 142 = 20•1 745 734 724 716 710 702 655 587 532	.00072 .00063 .00054 .00034 .00036 .00039 .00019 .00018 22 OFF .000129 .00129 .00124 .00119 .00119 .00119 .00019 .00019	2-149 2->39 2->27 2->39 3-455 3-879 4-334 4-994 6-148 3-968 0-000 -287 ->38 7-62 ->904 1-106 1-603 2-147 2-32	389-9 407-8 408-3 426-8 438-9 447-7 457-6 468-9 559-8 355-7 317-3 308-6 333-1 368-6 399-1	2-182 3-420 3-470 5-574 10-381 16-970 27-775 57-396 87-714 144-197 2-162 1-276 1-009 1-000 1-000 1-303 2-216 3-491	1-020 1-243 1-347 1-503 1-506 1-612 1-678 1-731 1-787 1-820 1-848 0-000 -202 -388 -524 -616 -676 -741 1-019 1-244	341 373 374 401 430 444 452 459 152 163 252 313
20.00 40.83 100.00 200.00 000.00 000.00 1.00 1.00 1	30.00 15.00 14.70 6.00 3.00 1.50 	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5085.6 4999.5 4927.5 R 6769.6 6576.3 6502.4 6447.3 6382.5 6037.6 5642.7 5386.6 55642.7 5386.6 55163.2	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-91 9-92 9-93 9-93 9-93 9-97 9-963 9-97 10-013	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3362 1.3562 1.3562 1.3562 1.1659 1.1635 1.1917 1.1970 1.1970 1.1970 1.2378 1.2159	1.0682 1.0237 .9928 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL 1.55012 1.4440 1.3379 1.3400 1.3324 1.3501 1.0408 .9888 .9882	540 485 429 428 358 307 261 207 172 142 = 20-1 745 742 734 716 710 702 655 587 532 477	.00072 .00063 .00054 .00054 .00036 .00036 .00019 .00019 .00012 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129 .00129	2-149 2-539 2-927 2-927 3-455 3-879 4-334 6-148 3-968 0-000 -287 -502 -904 1-000 1-106 1-603 2-147 2-532 2-914	989-9 407-8 408-3 426-8 438-3 447-7 457-6 463-6 468-5 559-8 355-7 317-3 308-6 308-6 333-1 368-0 390-1 408-6	2+182 3+420 2+476 5-554 10-381 10-381 10-950 27-755 53-398 87-714 144-197 2-162 1-208 1-000 1-000 1-303 2-216 3-491 3-620	1-020 1-263 1-397 1-503 1-506 1-612 1-678 1-791 1-820 1-820 1-848 0-000 -202 -388 -224 -616 -676 -676 -710 1-019 1-264 1-401 1-509	3413 373 374 401 430 444 459 129 159 159 159 252 313 346 373
20.00 40.83 100.00 200.00 000.00 000.00 1.00 1.00 1	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .60 .60 .60 .60 .60 .60 .60 .60 .60	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6037.6 5642.7 5386.6	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-919 9-923 9-995 9-997 9-997 9-999 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-99 9-9 9	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3282 1.3562 1.3562 1.3562 1.1849 1.1859 1.1859 1.1859 1.1946 1.1979 1.1998 1.2169	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL .1.4856 1.4440 1.3979 1.3600 1.3979 1.3008 1.1551	540 485 429 428 358 307 261 207 172 142 = 20•1 745 734 724 716 710 702 655 587 532	.00072 .00063 .00054 .00034 .00036 .00039 .00019 .00018 22 OFF .000129 .00129 .00124 .00119 .00119 .00119 .00019 .00019	2-149 2->39 2->27 2->39 3-455 3-879 4-334 4-994 6-148 3-968 0-000 -287 ->38 7-62 ->904 1-106 1-603 2-147 2-32	389-9 407-8 408-3 426-8 438-9 447-7 457-6 468-9 559-8 355-7 317-3 308-6 333-1 368-6 399-1	2-182 3-420 3-470 5-574 10-381 16-970 27-775 57-396 87-714 144-197 2-162 1-276 1-009 1-000 1-000 1-303 2-216 3-491	1-020 1-243 1-347 1-503 1-506 1-612 1-678 1-731 1-787 1-820 1-848 0-000 -202 -388 -524 -616 -676 -741 1-019 1-244	3413 373 374 401 430 444 452 452 1152 1152 1152 1153 1153 1153 1153 11
20-00 40-80 40-83 100-00 200-00 400-00 000-00 100-00 1-05 1-20 1-40 1-60 1-77 2-00 4-00 10-00 20-00 4-083 10-00	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .60 .60 .60 .60 .60 .60 .60 .60 .60	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356 1990 1737 1507 1501	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5085.6 4999.5 4927.5 8 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 5382.5 6037.6 5163.0 5153.0 75386.6	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-19 9-19 9-19 9-19 9-19 10-013 10-015 10-016	1.2537 1.2670 1.2811 1.3018 1.3152 1.3282 1.3418 1.3502 1.3562 1.3562 1.1849 1.1859 1.1835 1.1917 1.1917 1.1998 1.2169 1.22378 1.2378 1.2378 1.2471 1.2515 1.2647 1.2634	1.0682 1.0237 .9828 .9816 .9315 .8976 .8727 .8465 .8313 .8210 .8210 .4456 1.4456 1.4456 1.3979 1.3600 1.3924 1.3924 1.3928 1.4928 1.492	540 485 428 358 307 261 207 172 142 = 20-1 745 744 724 716 710 702 655 587 532 475 403	.00072 .00063 .00054 .00054 .00036 .00030 .00019 .00016 .000129 .000129 .00129 .00129 .00129 .00130 .00130 .00030	2-149 2-539 2-939 3-879 3-879 3-879 4-334 4-994 5-544 6-148 - 3-968 0-000 -287 ->58 -762 -904 1-106 1-603 2-147 2-926 3-431	989-9 407-8 408-3 426-8 438-9 447-7 457-6 468-9 559-8 355-7 317-3 308-6 307-3 308-6 333-1 408-6 409-1 428-3	2+182 3+420 2+476 5-554 10-381 10-381 10-950 27-755 53-398 87-714 144-197 2-162 1-208 1-000 1-000 1-303 2-216 3-491 3-620	1-020 1-263 1-397 1-506 1-612 1-678 1-791 1-787 1-820 1-848 0-006 -202 -388 -524 -616 -676 -741 1-019 1-264 1-401 1-509 1-512	341 373 374 401 430 444 452 459 0 0 129 152 167
20.00 40.00 40.83 100.00 200.00 400.00 000.00 1.00 1.05 1.20 1.40 1	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .50 .60 .50 .60 .60 .60 .60 .60 .60 .60 .60 .60 .6	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356 1990 1737 1507 1507 1507	6220.9 9967.7 3749.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6382.5 6037.6 5642.7 5386.6 5163.7 5157.7 4914.9	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-919 9-923 9-935 9-957 9-957 9-957 9-999 10-013 10-016 10-016	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3282 1.3562 1.3562 1.3562 1.1849 1.1635 1.1916 1.1936 1.1937 1.1946 1.1938 1.2169 1.2378 1.2515 1.2647 1.2655 1.2834	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL .14856 1.4440 1.3979 1.3600 1.3324 1.3008 1.9008 .9488 .9482 .9471	540 485 429 428 356 307 261 172 142 201 745 745 774 774 774 774 774 774 774 774	.00072 .00063 .00054 .00054 .00036 .00030 .00039 .00019 .00018 .00129 .00124 .00119 .00112 .00112 .00119 .00092 .00092 .000957 .000957	2.149 2.539 2.939 3.455 3.879 4.334 4.994 5.544 6.148 3.968 0.000 2.87 2.58 2.904 1.000 1.106 1.603 2.147 2.532 2.914 2.926 3.842	989-9 407-8 408-3 426-8 438-3 447-7 457-6 463-6 468-5 559-8 355-7 317-3 308-6 333-1 408-6 409-1 428-3 440-3	2-182 3-820 3-820 3-826 3-826 10-381 16-950 27-725 53-398 87-714 184-197 2-162 1-228 1-009 1-000 1-010 1-303 2-216 3-891 3-620 5-701 10-754	1-020 1-263 1-397 1-503 1-506 1-612 1-678 1-731 1-820 1-846 0-000 -202 -388 -524 -616 -676 -741 1-019 1-204 1-401 1-509 1-512	3413 373 374 401 430 444 452 459 129 152 167 125 252 313 346 373 374 401
20-00 40-00 40-83 100-00 200-00 000-00 000-00 1-05 1-20 1-40 1-60 1-77 2-00 4-00 10-00 20-00 4-083 100-00	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .60 .60 .60 .60 .60 .60 .60 .60 .60	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 2699 2647 2356 1990 1737 1507 1501	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5085.6 4999.5 4927.5 8 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 5382.5 6037.6 5163.0 5153.0 75386.6	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-19 9-19 9-19 9-19 9-19 10-013 10-015 10-016	1.2537 1.2670 1.2811 1.3018 1.3152 1.3282 1.3418 1.3502 1.3562 1.3562 1.1849 1.1859 1.1835 1.1917 1.1917 1.1998 1.2169 1.22378 1.2378 1.2378 1.2471 1.2515 1.2647 1.2634	1.0682 1.0237 .9828 .9816 .9315 .8976 .8727 .8465 .8313 .8210 .8210 .4456 1.4456 1.4456 1.3979 1.3600 1.3924 1.3924 1.3928 1.4928 1.492	540 485 428 358 307 261 207 172 142 = 20-1 745 744 724 716 710 702 655 587 532 475 403	.00072 .00063 .00054 .00054 .00036 .00030 .00019 .00016 .000129 .000129 .00129 .00129 .00129 .00130 .00130 .00030	2-149 2-539 2-939 3-879 3-879 3-879 4-334 4-994 5-544 6-148 - 3-968 0-000 -287 ->58 -762 -904 1-106 1-603 2-147 2-926 3-431	989-9 407-8 408-3 426-8 438-9 447-7 457-6 468-9 559-8 355-7 317-3 308-6 307-3 308-6 333-1 408-6 409-1 428-3	2-182 3-420 5-554 10-381 16-950 27-755 53-396 87-744 144-197 2-162 1-258 1-061 1-009 1-000 1-010 1-303 2-216 3-491 5-620 5-701	1-020 1-263 1-397 1-506 1-612 1-678 1-791 1-787 1-820 1-848 0-006 -202 -388 -524 -616 -676 -741 1-019 1-264 1-401 1-509 1-512	3413 373 374 401 430 444 452 459 129 152 167 125 252 313 346 373 374 401
20.00 40.00 40.83 100.00 200.00 000.00 000.00 1.00 1.00 1.00 1.40 1.67 7.20 4.00 4.00 1.00 20.00 4.00 4.00 4.00 20.00 4.00 6.00	30.00 15.00 14.70 6.00 3.00 1.50 .15 .15 .15 .15 .15 .15 .15 .15 .15 .15	1575 1357 1350 1104 937 792 526 439 2944 2923 2866 2800 2742 2697 1507 1501 1238 1059 900 720	6220.9 5967.7 5749.0 5743.0 5506.6 5354.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6382.5 6037.6 5042.7 5163.7 7386.6 5163.7 7386.6 4476.0	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 10-010 10-016 10-016 10-016	1.2537 1.2670 1.2811 1.2811 1.308 1.3152 1.3282 1.3418 1.3502 1.3562 1.3562 1.1859 1.1835 1.1917 1.1917 1.1919 1.1937 1.1937 1.1937 1.2651 1.2651 1.2834 1.2834 1.2834 1.3125 1.3291	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 .8210 .14856 1.4440 1.3979 1.3600 1.3979 1.3970 1.39	540 485 429 428 358 307 172 261 207 172 142 200.1 745 774 774 774 774 774 774 774 774 774	.00072 .00063 .00054 .00054 .00036 .00030 .00039 .00019 .00018 .00129 .00124 .00119 .00112 .00112 .00119 .00092 .00092 .000957 .000957	2-149 2-539 2-527 2-739 3-879 4-334 4-994 5-544 6-148 3-968 	989-9-407-8-407-8-407-8-407-8-407-8-407-8-407-8-20-8-408-9-408-6-20-8-8-8-8-8-8-8-8-8-8-8-8-8-8-8-8-8-8-	2-182 3-820 3-820 3-826 3-826 10-381 16-950 27-725 53-398 87-714 184-197 2-162 1-228 1-009 1-000 1-010 1-303 2-216 3-891 3-620 5-701 10-754	1-020 1-263 1-397 1-503 1-506 1-612 1-678 1-731 1-820 1-846 0-000 -202 -388 -524 -616 -676 -741 1-019 1-204 1-401 1-509 1-512	3413 373 374 401 430 444 452 459 129 252 313 346 418 432
20.00 40.00 40.83 100.00 200.00 000.00 000.00 1.00 1.05 1.20 1.40 1	30.00 15.00 14.70 6.00 3.00 1.50 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .60 .30 .15 .50 .60 .50 .60 .60 .60 .60 .60 .60 .60 .60 .60 .6	1575 1357 1350 1104 937 792 629 526 439 2944 2923 2866 2800 2742 22699 2647 1507 1507 1507 1501 1238 1059 900	6220.9 9967.7 5749.0 5743.0 5506.6 5354.4 5225.4 5085.6 4999.5 4927.5 R 6769.6 6741.0 6663.6 6576.3 6502.4 6447.5 6382.5 6037.6 5642.7 5386.6 5163.1 5157.7 4914.9 4914.9 49757.3 4622.8	9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-216 9-219 9-91 9-923 9-935 9-971 9-997 10-013 10-016 10-016 10-016 10-016	1.2537 1.2670 1.2811 1.2815 1.3008 1.3152 1.3282 1.3282 1.3282 1.3562 1.3562 1.1849 1.1659 1.1659 1.1659 1.1970 1.1970 1.2169 1.2378 1.2169 1.2647 1.2647 1.2647 1.2684 1.2884 1.2984 1.2984	1.0682 1.0237 .9828 .9816 .9325 .8996 .8727 .8465 .8313 .8210 NT FUEL 1.5012 1.4856 1.4440 1.3979 1.3600 1.3924 1.3008 1.1551 1.0408 .9488 .9482 .9471 .8988 .9482 .9481	540 485 429 428 358 307 172 142 201 1742 745 742 7702 655 587 7702 473 473 473 473 473 473 473 473	.00072 .00063 .00054 .00034 .00036 .00039 .00019 .00012 .00129 .00124 .00115 .00119 .00129 .00129 .00129 .00129 .00139 .0	2.149 2.539 2.927 3.8579 4.334 4.994 5.544 6.148 3.968 0.000 .267 .558 .704 1.000 1.106 1.106 1.106 2.100 2.000 2.	989-9 407-8 408-8 426-8 438-9 447-7 457-6 463-6 468-5 559-8 355-7 317-3 308-6 307-3 308-6 308-3 308-6 409-1 428-3 450-2	2-182 3-420 3-470 5-574 10-381 16-970 27-775 53-398 87-714 144-197 2-162 1-228 1-009	1-020 1-263 1-397 1-503 1-506 1-612 1-678 1-731 1-820 1-846 0-000 -202 -388 -524 -616 -676 -741 1-019 1-204 1-401 1-509 1-512 1-690 1-745	346 373 374 401 430 444 459 50 50 152 167 183 252 313 346 373 374

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASCIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID (XYGEN

(d) Continued. Combustion-chamber pressure, 600 poinds per square inch absolute, equilibrium composition during isentiopic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos - ity, #,	Thermal conductivity,	Mach number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	Specific impulse
P _c /P	No∕sqin. abs	°K	col/g	900	γ	col/(g)(°K)	micro poises	k, col/(sec)(°K.(cm)	M	I _{rac,} (lb)(sec)/lb	e	C ^t	I, (16)(sec)/(
				2 = 0.600	. PFRCI	ENT FUEL	= 17.	35. O/F	= 4.76	l .		·	
				T	1.1593	1.7671	803		0.000			0.000	
1.00	600.00 571.43	3208 3189	5841.6 5814.3	11.347 11.356	1.1598	1.7482	801	0.00150 .00158	.291	546.7	2.144	• 200	48.
1.20	500.00	3137	5740.5	11.379	1.1611	1.6966	794	+00152	•564	347.8	1.250	.385	93.
1.40	428.57 375.00	3077	5656.9 5586.0	11.404	1.1629	1.6375	786 779	+001+6	•770 •913	310.8	1.057	-520 -612	126.
1.75	342.61	2990	5538.8	11.438	1.1659	1.5531	774	-00137	1.000	301.5	1.000	. 666	162.
2.00	300.00 150.00	2938 2669	5470.4 5134.6	11.457	1.1680	1.5041	766 727	+00132 +00108	1.117	303.1	1.012	1.017	179.
4.00	120.00	2009	3134.0	11.555		1.2/23	127	•00100	1.013	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1.727	1.01	
10.00	60.00	2313	4742.5	11.593	1.2048	1.0538	667	+00085	2.145	365.0	2.288	1.268	309.
20.00	30.00	2050	4483.6 4255.3	11.609	1.2216	.9574 .8996	617 564	•00072 •00063	2.517	388.2 407.6	3.644 5.926	1.524	343.
40.00	15.00 14.70	1803 1796	4249.0	11.615	1.2363	.8983	562	.00063	2.896	408.2	6.013	1.527	372.
					1 2-20	04.03	400	*****	2 201	429.7	11 474	1 443	
200.00	6.00 3.00	1506 1306	3996.4	11.616	1.2528	.8482 .8136	490	•00052 •00045	3.381	428.7	19.054	1.716	400
400.00	1.50	1125	3686.0	11.616	1.2806	.7807	379	+00038	4.182	452.4	31.724	1.776	433.
		0).6	2524 4	11 414	1 2004	74.74	311		4.769	464.0	42.274	1.841	448.
1000 • 00 2000 • 00	•60 •30	916 778	3526.4 3426.2	11.616	1.2996	•7420 •7177	264	-00030 -00025	5.257	471.1	103-640	1.880	458.
4000+00	.15	658	3341.2	11.616	1.3245	.6983	222	•00040	5.791	476.9	172.288	1.913	466.
		•		- 0.700	. PERCE	NT FUEL	= 15•2	5, 0'F	= 5+556	· · · · · · · · · · · · · · · · · · ·			
1.00	600.00	3381	5138.3	12.664	1.1429	2.1301	846	0.001+7	0.000			0.000	0.
1.05	571.43	3364	5112.5	12.677	1.1430	2.1115	843	.00195	.293	531.5	2.133	.199	47.
1.20	500.00 428.57	3317 3263	5042.7	12.711	1.1433	2.0594	837 830	.00189	•568 •775	338.5	1.245 1.054	.383 .517	91. 123.
1.60	375.00	3217	4896.2	12.782	1.1443	1.9428	823	.00176	920	295.1	1.006	-609	145.
1.74	345.24	3186	4855.0	12.802	1.1447	1.9085	819	.001/2	1.000	294.1	1.000	.659	157
2.00 4.00	300.00 150.00	3140 2903	4786.1 4463.7	12.834	1.1456	1.8496	813 779	.00136	1.125	295.9 322.1	1.014	1.016	175. 242.
4.00	120.00	2,03	440311	,,,	1,1,1,1	11,,,,,,							
10.00	60.00	2584	4080.8	13.115	1.1702	1.2090	730 688	.00102	2.148	359.5	2.356 3.8g3	1.273	303.
20.00 40.00	30+00 15+00	2337	3823.0	13-174	1.1884	1.0195	540	+00013 +00010	2.855	404.1	6.256	1.539	366.
40.83	14.70	2081	3585.6	13.203	1.2072	.8980	638	•000-9	2.866	404.6	6.350	1.542	367.
				10 21.		.8183	571	7	3.327	426.4	12.271	1.646	397.
200.00	6.00 3.00	1775	3326.0	13.214	1.2263	.7809	515	*00037	3.700	440.2	20.571	1.744	415.
400.00	1.50	1359	3000.6	13.216	1.2515	.7484	459	+000+3	4.089	451.9	34,597	1.809	431.
	4.0	1126	2020 0	12 214	1 2606	.7080	387	•00015	4.637	464.6	68.879	1.880	448.
1000+00 2000+00	•60 •30	1125 968	2829.9	13.216	1.2696	.6798	334	.00019	5.087	472.4	115.835	1.924	458.
4000.00	.15	828	2627.5	13.216	1.2978	•6552	286	•000 ₹4	5.575	479.0	194.445	1.961	467.
			F	= 0.800	. PERCE	NT FUEL	= 13.6	0. 0'F	= 6.349)			
1.00	600+00	3481	4586.9	13.859	1.1337	2.4909	875	0.00234	0.000			0.000	0.
1.05	571.43	3465	4562.6	13.875	1.1335	2.4777	873	.00232	•294 •570	515.6 328.6	2.126	.198	46. 88.
1.20	500+00 428+57	3422	4496.8	13.919	1.1331	2.4401	867 861	.00227 .00221	.778	194.1	1.052	.516	119.
1.60	375.00	3331	4358.6	14.012	1.1324	2.3513	855	.00216	.924	286.7	1.006	.607	140.
1.73	346.81	3306	4321.9	14.037	1.1323	2.3254	851	-00213	1-000	286.0	1.000	.733	151.
2.00 4.00	300.00 150.00	3261	4254.6	14.082	1.1321	2.2752	845 816	•00237 •00177	1.129	287.8 314.1	1.015	1.016	235.
7.00	170400				_								
10.00	60.00	2779 2568	3579.7 3327.2	14.522	1.1403	1.5823	775 741	•001 16 •001 17	2.155	351.9 376.8	2.409 3.944	1.427	331.
20.0C	3C • 00 15 • 00	2346	3097.0	14.745	1.1712	1.0267	703	-00044	2.837	398.3	6.587	1.552	360.
40.83	14.70	2340	3090.5	14.747	1.1718	1.0207	702	+00013	2.846	398.8	6.689	1.555	360.
100.00	4.00	2042	2826.6	14.800	1.1976	.8369	642	+00025	3.275	421.8	13.134	1.687	391.
200.00	6.00 3.00	1815	2647.3	14.812	1.2135	.7683	591	+000 15	3.623	436.6	22.231	1.771	410+
400• 0 0	1.50	1602	2488.5	14.815	1.2260	.7287	537	+000+8	3.991	449.2	37.727	1.842	427.
1000.00	•60	1347	2307.6	14.816	1.2422	.6880	464	.000.0	4.507	463.0	76.063	1.919	445.
2000.00	•30	1173	2190.6	14.816	1.2553	.6594	409	+00034	4.926	471.6	129.237	1.968	456.
4000.00	•15	1016	2089.0	14.816	1.2694	.6320	356	•000 28	5.375	478.9	219.200	2.009	466.
			,	= 0.900	PERCE	NT FUEL	- 12-2	8, 0'F	= 7.143		,	,	
1.00	600-00	3526	4142.9	14.930	1.1295	2.6696	896	0 • 0 0 2 14	0+000	F.0.7 .	2 132	0.000	٥٠
1.05 1.20	571.43 500.00	3511 3469	4120.1	14.948	1.1293	2.6628	894 888	•002 ·3 •002 ·9	.294 .571	500.1 318.8	2.123	.381	44. 85.
1.40	428.57	3422	3988.0	15.057	1.1277	2.6185	881	.002+5	.780	285.4	1.052	.515	116.
1.60	375.00	3382	3928.2	15-107	1-1270	2.5953	876 873	+002+2	1.000	278.3	1.005	.607 .653	136.
1.73 2.00	347.52 300.00	3360	3894.5 3830.1	15.136	1.1267	2.5526	866	.00235	1.132	279.4	1.016	.732	165.
4.00	150.00	3122	3540.7	15.441	1.1236	2.3886	839	.00214	1.633	305.3	1.350	1.016	228.
		1 1001	2100 /	15.751	1.1229	2.0940	803	.00141	2.161	342.8	2.437	1.278	287.
20.00	60.00 30.00	2881	3190.4 2947.8	15.963	1.1254	1.8100	775	.00131	2.512	367.9	4.032	1.431	322.
40.00	15.00	2528	2723.3	16.145	1.1327	1.4813	746	•00175	2.838	390.0	6.838	1.560	35ì.
40.83	14.70	2523	2716.9	16.150	1.1330	1.4712	745	•00121	2.848	390.6	6.947	1.563	352.
100.00	6.00	2279	2453.5	16.318	1.1553	1.0541	701	+00015	3.246	414.9	13.977	1.702	383.
200.00	3.00	2072	2270.2	16.384	1.1797	.8410	659	•000÷5	3.555	430.8	24.037	1.791	403.
400.00	1.50	1857	2105.2	16.408	1.1999	.7376	610	•00024	3.886	444.3	41.251	1.869	421.
1000.00	.60	1585	1914.5	16.415	1.2177	.6764	540	+000+5	4.367	459.3	84.153	1.954	440.
		1397	1789.5	16.416	1.2295	.6487	486	•00039	4.758	468.8	144.295	2.008	452.
2000.00	•30	. 4371	1679.6	101710	100-77	.6217	431	+00033	5.175	476.9	247.166	2.055	463.

(d) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, μ,	Thermal conductivity,	Mach	Specific impulse in vacuum.	Area ratio,	Thrust coefficient	
P _c /P	lb√sqin obs	T, °K	col/g	901	γ	col/(gill°ft)*	micro poises	k, col/(sec)(°K)(cm)	- 14	I vac,	ε	C*	L (b)(sec)/(b)
				· ? = 1.000). PERCE	ENT FUEL	,,	19, O/F	= 7.93			i	1
1.00	600.00	3534	3777.9	15.886	1.1283	2.6053	910	0+00251	0.000			0.000	0 • 0
1.05	571.43	3519	3756.4	15.906	1.1280	2.6007	907	•00250	.295	485.3	2.122	-198	43.3
1.20	500.00	3478	3698.1	15.961	1.1272	2.5874	902	•00247	.572	309.4	1.240	.381	83-3
1.40	428.57 375.00	3431 3392	3631.9 3575.5	16.024	1.1263	2.5703	895	•00244 •00241	•78 ₀	277.0	1.051	•515 •606	112.1
1.73	347.72	3370	3544.0	16-108	1.1251	2.5445	886	.00239	1.000	269.4	1.000	.652	142.
2.00	300.00	3327	3483.1	16.168	1.1244	2.5243	880	+00236	1.132	271.3	1.016	• 732	160-1
4.00	150.00	3137	3210.2	16.441	1.1212	2.4094	852	•00218	1.634	∠96.5	1.357	1.016	222.
10.00	60.00	2903	2879.3	16.785	1.1186	2.2079	817	•00192	2.162	333.1	2.445	1.278	279.6
20.00	30.00	2738	2649.6	17.030	1.1181	2.0216	791	•00171		357.7	4.055	1.432	313.
40.00	15.00	2578	2436.1	17.258	1.1191	1.8120	765	•00150	2.842	379.5	6.910	1.562	341.
40.83	14.70	2573	2430.0	17.265	1.1191	1.8056	764	•00149	2.852	380.1	7.022	1.565	342.5
100.00	6.00	2371	2177.0	17.526	1.1239	1.5117	728	+00120	3.255	404.6	14.326	1.706	373.
400.00	3.00 1.50	2214	1997.7 1832.3	17.695 17.830	1.1315	1.2810	697 663	•00099	3.558	421.1 435.6	25.124	1.799	393.
		2052	1032.3	17.630	1.1437	1.0054	003	•000B0	3.037	433.6	44.210	1.001	411.
1000.00	•60	1826	1634.9	17.947	1.1679	.8338	611	•00059	4.260	452.2	93.124	1.974	431.6
2000.00	• 30	1648	1501.7	17.991	1.1894	.7163	564	-00048	4.585	462.8	162.695	2.034	445.0
4000.00	•15	1470	1382.4	18.009	1.2091	.6444	514	•00040	4.942	472.0	282.648	2.087	456+
		· · · · · · · · · · · · · · · · · · ·		= 1+500	• PERCE	NT FUEL	= 7.7	49. O/F	=11.90	•			
1.00	600.00			19.463	1.1327		930	0.00163	0.000			0.000	0.0
1.20	500.00 571.43	3315	2563.9 2609.3	19.540	1.1321	1.5942	921 927	.00158 .00162	•571 •294	273.0 428.4	2.125	.381 .198	73.5
1.40	428.57	3267	2512.4	19.604	1.1317	1.5682	913	•00155	.779	244.3	1.052	.516	99.4
1.60	375.00	3226	2468.5	19.658	1.1314	1.5447	906	•00151	.924	238.3	1.006	-607	117.
1.73	346.93	3202	2443.3	19.690	1.1313	1.5306	903	•00150	1.000	237.6	1.000	+654	126.
2.00	300.00	3158	2396.7	19.748	1.1310	1.5034	896	-00146	1.130	239.1	1.015	.733	141.3
4.00	150.00	2953	2185.1	20.011	1.1313	1.3606	862	.00128	1.631	261.0	1.351	1.016	195.9
10.00	60.00	2692	1930.2	20.314	1.1356	1.1474	818	•00104	2.157	292.6	2.415	1.276	246.1
20.00	30.00	2496	1755.2	20.499	1.1432	.9816	78∠	•00086	2.509	313.5	3.967	1.428	275.5
40.00	15.00	2297	1594.7	20.640	1.1557	8274	743 742	•00070	2.841	331.7	6.664	1.554	299.6
40.83	14.70	2291	1590.2	20.643	1.1562	.8232	142	•00070	2.850	332.2	6.768	1.557	300 - 2
100.00	6.00	2026	1404.5	20.752	1.1791	.6682	685	•00054	3.268	351.9	13.428	1.691	326.0
200.00	3.00	1818	1277.1	20.792	1.1984	•5904	635	+00245	3.599	364.7	22.891	1.777	342.6
400.00	1.50	1616	1163.4	20.807	1.2152	•5432	582	•00039	3.950	375.6	39.039	1.850	356.7
1000.00	•60	1366	1033.2	20.812	1.2336	·5048	509	•00032	4.450	387.5	79.054	1.931	372.3
2000-00	• 30	1195	948.5	20.813	1.2462	.4834	454	•00027	4.858	395.0	134.733	1.982	382.1
4000-00	•15	1039	874.7	20.813	1.2594	.4636	401	•00023	5.296	401.4	229.310	2.025	390.4
			R	= 2.000	• PERCE	NT FUEL	= 5.9	27. 0/F	-15-873				
1.00	600.00	3158	2016.0	21.832	1.1414	1.1081	919	0.00112	0.000			0.000	0.0
1.05	571.43	3141	2002.0	21.850	1.1414	1.1005	917	•00111	.293	391.2	2.132	•199	34.9
1.20	500.00	3097	1964.2	21.900	1.1417	1.0794	909	•00108	-568	249.2	1.245	-383	67-1
1.40	428.57 375.00	3046	1921.3 1884.8	21.956	1.1421	1.0543	900 893	•00105 •00102	•776 •920	222.9 217.2	1.054	•517 •609	90 • 8
1.74	345.45	2975	1862.7	22.031	1.1430	1.0182	888	+00100	1.000	216.6	1.000	-658	115+5
2.00	300.00	2929	1825.1	22.078	1.1437	•9940	880	•00097	1.125	217.9	1.014	. 734	126.9
4.00	150.00	2706	1650.2	22.286	1.1496	.8720	840	•00083	1.624	237.3	1.341	1.016	178.4
10.00	60.00	2413	1442.0	22.490	1.1641	.7166	784	+00065	2.151	265.0	2.365	1.273	223.5
20.00	30.00	2189	1301.4	22.588	1.1804	.6182	737	+00054	2.507	283.0	3.829	1.421	249.4
40.00	15.00	1965	1174.9	22.642	1.1988	-5459	686	•00045	2.852	298.3	6.321	1.541	270 - 5
40.83	14.70	1959	1171.4	22.643	1.1994	•5441	684	+00045	2.863	298.7	6.416	1.544	271-1
100.00	6.00	1678	1028.7	22.670	1.2212	.4875	614	-00037	3.316	314.9	12.437	1.670	293.1
200.00	3.00	1475	932.9	22.676	1.2351	.4613	557	•00032	3.683	325.3	20.879	1.749	307.0
400.00	1.50	1289	849.1	22.677	1.2476	.4417	501	•00028	4.069	334.1	35.155	1.815	318.7
1000.00	•60	1070	754.5	22.677	1.2641	.4194	430	•00023	4.614	343.6	70.143	1.867	331.3
2000-00	•30	923	694.1	22.677	1.2770	•4040	378	•00019	5.059	349.5	118.235	1.932	339.2
000-00	•15	792	642.1	22.677	1.2904	.3894	329	•00016	5.539	354.5	199.011	1.970	345.8
			R	= 3.000	PERCE	NT FUEL	= 4+0	31. O/F	*23·810	1			
1.00	600.00		1381.4	24.718	1.1694	0.6509	869	0+00065	0.000			0.000	0 • 0
1.05	571.43	2729	1370.7	24.729		.6451	866	•00065	.289	342.7	2.152	.201	30.6
1.40	500.00 428.57	2679	1341.7	24.759 24.790	1.1749	.6293 .6114	856 845	.00062 .00060	.561 .766	217.9	1.254	.522	58 • 6 79 • 4
1.60	375.00		1281.1	24.815	1.1774	.5963	635	.00058	909	189.4	1.008	.613	93.4
1.76	340.99	2538	1261.7	24.832	1.1793	.5858	878	-00057	1.000	188.6	1.000	-670	102-1
2.00	300.00		1235.9	24.852	1.1819	.5720	819	•00755	1.112	189.5	1.011	.739	112.5
4.00	150.00	2231	1105.1	24.937	1.1703	•50>9	765	•00046	1.608	205.1	1.314	1.018	155.0
10.00	60.00	1913	953.9	24.990	1.2209	•4460	690	8E000•	2.146	227.2	2.253	1.266	192.9
20.00	30.00	1682	B54.9	25.003	1.2358	.4185	631	•00033	2.524	241.2	3.569	1.405	214-0
40.00	30.00 15.00	1470	768.2	25 • 007	1.2483	•4000	572	•00729	2.900	253.0	5.778	1.517	231.0
40.83	14.70	1454	765.8	25.007	1.2487	.3995	571	•00028	2.911	253.3	5.862	1.520	231.4
100.00	6.00	1220	670.5	25.008	1.2635	.3811	498	+00024	3.408	265.7	11.130	1.633	248.7
200.00	3.00	1053	608.0	25.008	1.2755	.3679	444	•00021	3.807	273.4	18.422	1.703	259.4
400.00	1.50	904	554.2	25.008	1.2879	.3555	392	•00018	4.229	279.9	30.593	1.761	268.3
000.00	•60	733	494.5	25+008	1.3053	.3398	329	+00014	4.829	286.9	59.908	1.824	277.8
20 00.0 0	•30	622	457.5	25.008	1.3185	3290	285	•00012	5.326	291.1	99.545	1.862	283.5
.000.00	•15	525		25.008	1.3312	.3194	245	•00010	5.868	294.6	165.173	1.893	288+3

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXY EN

(d) Concluded. Combustion-chamber pressure, 600 pounds per square inch absolute; equilibrium composition during isentropic expansion

Pressure ratio, P _c /P	Static pressure, P, Ib/sq in.	Temp- erature, T, "K	Enthalpy, h, cal/g	Molecular weight,	Isentropic exponent,	Specific heat, cp, cal/(g)(°K)*	Viscos- ity, µ, micro	Thermal canductivity, k, cal/(sec)(°K)(cm)	Mach number M	Specific impulse in vacuum,	Area ratia, E	Thrust coefficient, C _F	Specific impulse I,
	abs	.,				L	poises	1 :		(lb)(sec)/lb			
	600.00	2381	1054.4	26•323	1.2036	0.4697	806	054. O/F	0.000			0.000	0•
1.00	571.43	2362	1045.7	26.328	1.2048	.4663	802	+00045	•285	308.9	2.174	• 203	27.
1.40	500.00 428.57	2309 2249	1022.1 995.6	26.340	1.2079	.4572 .4473	790 777	•00044 •00042	•554 •756	196.0 174.7	1.263	•390 •526	53. 71.
1.60	375.00 336.49	2198 2157	973.2 955.5		1.2149	.4393 .4332	765 756	•00041 •00040	.898 1.000	169.8	1.010	.618	84. 92.
1.78 2.00	300.00	2113	937.0	26.374	1.2202	.4272	746	•00039	1.099	169.6	1.009	•744	101.
4.00	150.00	1860	833.4	26-396	1.2355	.3982	685	•00034	1.599	182.6	1.293	1.020	138.
10.00	60 • 00 30 • 00	1554 1348	715.9 640.3	26.405	1.2521	.3743	605 546	•00028 •00025	2.150	201.3	2.182 3.423	1.263	171.
40.00	15.00	1164	574.8	26+406	1.2741	.3499	491	•00022	2.931	222.9	5.493	1.503	204.
40.83	14.70	1159	573.1	26+406	1.2744	.3495	489	•00022	2.943	223.2	5.572	1.506	204.
100.00 200.00	6.00 3.00	952 813	502.1 456.1	26.406 26.406	1.2895	.3352 .3243	421 371		3.458 3.876	233.4	10.461 17.162	1.613	219.
400.00	1.50	690	417.0	26.406	1.3153	.3139	325		4.320	245.1	28.237	1.733	
1000.00	•60	551	374.4	26.406	1.3331	.3012	269	•00011	4.959	250.7	54.608	1.790	243.
2000 • 00 4000 • 00	•30 •15	463 386	348.0	26.406 26.406	1.3564	•2927 •2864		•00009 •00007	5.492	254.0	89.893 147.835	1.824	247.
-9000-00		. ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,						458, O/F					1
1.00	600.00	2072	855.0	27.317	1.2317	0.3924	742	0.00036	0.000			0.000	0 • 1
1.05	571.43 500.00	2053	847.7	27.319	1.2327	•3906 •3859	738 725	.00036 .00035	•282 •548	282.7 179.1	2.190 1.270	• 204 • 393	25 ·
1.40	428.57	1944	805.9	27.326	1.2387	.3808	711	.00034	.749 .890	159.4	1.067	•530	65 • 4 76 • 8
1.60	375.00 333.54	1894 1852	787.2 771.3	27.329 27.331	1.2413	.3767 .3734	689	•00032	1.000	154.0	1.000	•622 •691	85 - 3
2.00	300.00 150.00	1813 1578	757.2 671.8	27.332 27.337	1.2455	.3706 .3559	679 617		1.092	154.4	1.201	.747 1.023	92.
				1			539		2.152		2.143	1.262	
20.00	60.00 30.00	1303	576.1 515.1	27.339	1.2710	.3410 .3309	484	•00023 •00026	2.551	192.6	3.341	1.393	172.0
40.00 40.83	15.00 14.70	961 956	462.7 461.3	27.339	1.2929	•3209 •3206	432	.00018 .00018	2.948	201.2	5.329 5.405	1.497	185.
100.00	6.00	777	405.0	27.339	1.3095	•3076		•00015	3.486	210.3	10.063	1.603	197.
400.00	3.00 1.50	658 554	368.9 338.4	27.339 27.339	1.3228	.2979 .2887	321 279	.00012 .00011	3.919 4.380	215.8	16.396 26.787	1.666	205.
1000.00	•60 •30	438 365	305.5 285.3	27.339 27.339	1.3536	.2782 .2728	195	•00008 •00007	5.049 5.614	225.0 227.8	51.327 83.959 137.411	1.771	222.6
4000-00	•15	303	268.6	27.339	1.3697	.2693	164	■00006	5.236	230.1	137.411	1.830	225.
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TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(e) Combustion-chamber pressure, 60 pounds per square inch absolute, frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, #,	Thermal conductivity,	Mach number	Specific impulse in yacuum,	Area ratio,	Thrust coefficient	Specific impulse I,
P _C /P	lb√sqin. orbs	°K	coi/g	9371	γ	col/(g)(°K)*	micro poises	cal/(sec)(°K)(cm)	M	I vac. (lb)(sec)/lb	ε	C ^t	(lb (sec)/(
			,	R = 0.150	PERCE	NT FUEL	= 45**	55, O/F	= 1.19	0			
1.00	60.00	1183	5313.5	4.416	1.3396	1.7753	314	0.00073	0.000			0.000	0.
1.05	57.14	1168	5287.7	4.416	1.3406	1.7710	311	•00073	.271	530.0		.210	47.
1.20	50 • 00 42 • 86	1129	5218.5 5141.8	4.416	1.3436	1.7597 1.7472	303 293	•00070 •00068	•527 •722	334.2 296.1	1.297	.403 .543	90 • 122 •
1.60	37.50	1049	5077.7	4.416	1.3497	1.7369	285	•00066	.B60	286.6	1.018	.636	143.
1.87	32.17	1008	5006.8	4.416	1.3528	1.7257	276	•00063	1.000	284.1	1.000	.725	163
2 • 00 • • 00	30 • 00 15 • 00	989 824	4975.4	4.416 4.416	1.3540	1.7210	272	•00062 •00052	1.566	284.4 301.7	1.003 1.233	1.031	232.
4.08	14.70	819	4685.8	4.416	1.3654	1.6815	232	•00052		302.3	1.244	1.038	233.
10.00	6.00	643	4392.5	4.416	1.3748	1.6505	188	+00042	2.152	327.5	1.974	1.257	283.
20.00 40.00	3.00 1.50	532 439	4209.8 4058.9	4.416	1.3799	1.6344	159 133	+00035 +00029	2.586	343.5	2.982 4.620	1.376	
											-		
100.00 200.00	•60 •30	340 280	3899.0 3802.6	4.416	1.3882	1.6093	104 85	•00023 •00018	3.64B 4.149	369.8 377.7	8.432 13.431	1.558	350 • 362 •
400.00	.15	230	3723.2	4.416	1.4068	1.5562	70	•00015	4.675	384.1	21.488	1.652	372
1000.00	•06	175	3640.1	4.416	1.4349	1.4847	55	•00011	5.438	390.6	39.928	1.694	381.
2000.00	•03	142	3590.9	4.416	1.4550	1.4389	45	•00009	6.096	394.3	63.572	1.719	387.
4000+00	•02	114	3551.2	4.416	1.4705	1.4065	36	•00007	6.845	397.3	100.938	1.739	391.
			R	= 0.200	• PERCE	NT FUEL	= 38 • 6	5. 0/F	= 1 · 587	, ,			
1.00	60.00	1514	2969.7	5.216	1.3079	1.6183	402	0.00084	0.000			0.000	.04
1.05 1.20	57.14 50.00	1497	2941.7 2866.8	5.216	1.3090	1.6140	399 389	•00083 •00081	•274 •533	552.1 348.6	2.233 1.289	• 209 • 400	94
1.40	42.86	1398	2783.2	5.216	1.3155	1.5887	378	•0007B	.730	309.3	1.077	.539	127
1.60	37.50	1354	2713.2	5.216	1.3185	1.5772	369	•00076	.869	299.6	1.016	•632	149.
1.85 2.00	32.49 30.00	1307 1282	2640.5	5.216	1.3217	1.5651	359 353	•00073 •00072	1.000	297.3 297.8	1.000 1.004	.716 .757	169.
4.00	15.00	1079	2290.0	5.216	1.3391	1.5045	307	•00061	1.572	316.7	1.244	1.029	243.
4.08	14.70	1073	2281.6	5.216	1.3295	1.5031	306	•00061	1.585	317.4	1.256	1.035	244.
10.00	6.00	852	1954.3	5.216	1.3559	1.4516	251	+00048	2.148	344.7	2.009	1.257	297.
20.00	3.00	709 588	1748.8 1578.0	5.216 5.216	1.3656	1.4232	213 179	•00040	2.573 3.010	362 • 0 376 • 0	3.049 4.739	1.379	325 ·
40-00	1.50	200	15/0.0	3.216	1.3/15		177	•00034	3.010	310.0	74/37	1.412	
100.00	•60	458	1396.4	5.216	1.3771	1.3913	142	•00026	3.619	390.5	8.679	1.565	370
400.00	•30 •15	379 312	1286.2 1195.2	5.216 5.216	1.3811	1.3807	117 96	•00022 •00018	4.111 4.638	399.1 406.1	13.870 22.295	1.619	382. 392.
2000-00	•06 •03	242 198	1099.0	5.216 5.216	1.3973	1.3400	74 61	•00013 •00011	5.394	413.4	41.978 67.687	1.706	403 • 409 •
4000.00	•02	161	994.0	5.216	1.4350	1.2568	50	•00009	6.704	421.1	108.753		414.
			R	= 0.250	• PERCE	NT FUEL	= 33•5	1, 0/F	= 1.984				
1.00	60+00	1816	1249.3	6.015	1.2835	1.4954	481	0.00092	0.000			0.000	0•
1.05	57.14	1797	1220.2	6.015	1.2845	1.4916	477	•00091	.276	563.4	2.219	.207	50•
1.20	50.00	1744	1142.1	6.015	1.2871	1.4812	467	.00088	.536	356.1	1.283	.398	96.
1.40	42.86 37.50	1685	1054.8 981.6	6.015	1.2901	1.4692	456 446	•00086 •00083	•736 •876	316.2 306.6	1.073	.536 .629	130.
1.83	32.78	1586	910.0	6.015	1.2955	1.4484	436	•00081	1.000	304.5	1.000	.708	171.
2.00 4.00	30.00 15.00	1554 1322	864.1 535.4	6.015	1.2973	1.4414	429 378	•00080 •00068	1.076	305.1 325.4	1.005	.754 1.027	183. 249.
4.08	14.70	1315	526.5	6.015	1.3130	1.3857	376	.00068	1.592	326.1	1.267	1.033	250.
10.00	6.00	1057	176.7	6.015	1.3330	1.3224	314	•00054	2.147	355.2	2.048	1.258	305.
20.00	3.00	886	9954.7	6+015	1.3461	1.2847	269	• 00046	2.563	373.6	3.127	1.382	335.
40.00	1.50	740	9768.9	6.015	1.3569	1.2558	228	•00038	2.987	388.5	4.883	1.478	358.
100.00	+60	580	9570.0	6.015	1.3664	1.2320	181	•00030	3.581	404+1	8.984	1.575	382.
200.00	•30	481 399	9448.9	6.015	1.3717	1.2191	151 124	•00025	4.064	413.3 420.8	14.394 23.204	1.630	395. 406.
400.00	•15	399	9348.4	6.015	1.3755	1-2100	124	•00020	4.702	420.0	23.204	1.012	
1000.00	•06	310	9241.7	6.015	1.3821	1.1948	95	•00015	5.328	428 • 6	43.886	1.722	418.
2000.00 4000.00	•03 •02	256 210	9177.2 9124.0	6.015	1.3886	1.1805	78 64	+00012 +00010		433.3 437.0	115.624	1.749	424.
7000100												L	
, , , ,		3000		6.812	1.2649	1.3928		7, 0/F 0.00097	= 2.381			0:000	0•
1.00	60+00 57+14	2089 2068	9932.7 9903.2	6.812	1.2657	1.3928	550 546	•00096	0.000 .278	568.1	2.208	0+000 •206	50•
1.20	50.00	2011	9823.7	6.812	1.2678	1.3811	536	•00094	•541	359.4	1.278	.396	97.
1.40	42.86 37.50	1946 1891	9734.8 9660.0	6.812 6.812	1.2704	1.3707	524 514	•00091 •00089	.741 .881	319.4	1.071	.533 .626	131.
1.82	33.01	1840	9590.5	6.812	1.2750	1.3527	504	•00.387	1.000	307+9	1.000	•701	172.
2.00 4.00	30.00 15.00	1803 1547	9539.8 9201.7	6.812 6.812	1.2767	1.3460	497	•00085 •00074	1.082	308.6 330.1	1.265	1.025	184.
4.00	14.70	1540	9192.5	6.812	1.2906	1.2958	446	•00073	1.598	330.8	1.276	1.032	253
			8828.7	6.812	1.3101	1.2326	374		2.148	361.2	2.084	1.260	310.
20.00	6.00 3.00	1252 1059	8595.4	6.812	1.3254	1.1882	324	•00060 •00050	2.555	380+5	3.204	1.386	341.
40.00	1.50	891	8398.6	6.812	1.3389	1.1525	277	•00042	2.969	396.3	5.032	1.485	365.
100.00	•60	704	8186.3	6.812	1.3535	1.1170	222	•00033	3.545	412.7	9.315	1.584	389.
200.00	•30	587	8056.1	6.812	1.3607	1.1005	186	•00027	4.015	422.5	14.975	1.642	404+
400.00	•15	487	7947.8	6.812	1.3669	1.0868	155	•00023	4.519	430.5	24.203	1.689	415.
1000.00	•06	381	7832.4	6.812	1.3727	1.0745	119	+00017	5.249	438.8	45.935	1.738	427.
	•03	315	7762.2	6.812	1.3777	1.0640	97 79	•00014	5.855 6.>13	443.8 447.9	74.800 121.990	1.766	
000.00	•02	260	7704.2	6.812	1.3833	1.0529							

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID CXYGEN

(e) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	h,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, #,	Thermal conductivity,	nomber	Specific impulse in vacuum,	Area	Thrust coefficient,	Specific impulse,
P _c /P	No/sqin. abs	ĸ	col/g	9D1	γ	C _{p.} cal/(g)(°K)*	micro poises	k, col/seci(°K)(cm)	м	I _{voc.} (lb)(sec)/lb	ε	C ^t	L (8)(sec)/(8
				= 0.350	. PERCE	NT FUEL	= 26.4	47, O/F	= 2.778	3		_	.
1.00	60.00	2329	8892•B	7.597	1.2510	1.3038	508	0:00099	0.000	540	2 100	0.000	0.0
1.05	57.14 50.00	2307 2245	8863.2 8783.7	7.597 7.597	1.2516	1.3011	604 594	-00098	•28g	568.1 359.7	2.199 1.274		50 • 7 97 • 4
1.40	42.86 37.50	2175	8694.6 8619.6	7.597 7.597	1.2556	1.2849	582 572	+00094 +00092	•745 •886	319.9	1.069	.532	131.3
1.60	33.18	2065	8552.7	7.597	1.2593	1.2705	563	+00090	1.000	308.6	1.012	.696	172.0
2.00 ·	30 • 00 15 • 00	2023	8498.8	7.597 7.597	1.2608	1.2646	555 501	.00088 .00078	1.087	309.5 331.6	1.006 1.273	-750 1-024	185•2 253•0
4.08	14.70		8148.1	7.597		1.2198	499	.00077	1.603	332.4	1.286		254.0
10.00	6.00	1430 1219	7777.6 7537.8	7.597 7.597	1.2906	1.1616	429 376	.00064	2.150	363.7 383.8	2.114	1.261	311.5
40.00	3.00 1.50		7334.0	7.597	1.3057	1.0765	325	-00054 -00046	2.955	400.2	3.272 5.170	1.390	368.3
100.00	•60	823	7112.3	7.597	1.3303		263	+00036	3.515	417.4	9.636		393.
400.00	•30 •15	689 575	6975.5 6861.1	7.597 7.597	1.3490	1.0110 .9946	221 185	-00030 -00024	3.970 4.461	427.7 436.0	15.552 25.218	1.653	408-4
1000.00:	•06	451	6738.6	7.597	1.3645	•9790	145	-00019	5.172	444.8	48.013	1.753	432.9
2000.00	•03 •02	375	6664.0	7.597 7.597	1.3696	.9692	118	00015	5.763	450.1 454.4	78.373 128.116	1.783	440.
		1	• • • • • • • • • • • • • • • • • • • •	l.	L	NT FUEL	= 23.9		* 3.175		L *	1	
1.00	60.00	2531	8050•5	8.363	1.2404	1.2259	656	0-00+00	0.000			0.000	0 • (
1.05	57.14 50.00		8021.3 7942.8	8.363	1.2410	1.2237	653 642	·00099	.281		2.193	•205	50 • 4 96 • 8
1.20	42.86	2371	7854.5	8.363	1.2444	1.2099	621	-00095	.748	318.3	1.271	-530	130.
1.60	37.50 33.31	2309 2256	7780•4 7716•2	8.363 8.363	1.2461	1.2033	620 611	+00093	.889 1.000	309.0	1.012	•623 •693	153.
2.00	30.00	2209	766046	8.363	1.2490	1.1919	603	-00090	1.091	308.2	1.007	• 748	184.
4.00 4.08	15.00 14.70	1920 1912	7321.0 7311.7	8.363 8.363	1.2591	1.1547	549 548	-00080	1.594	330.7 331.5	1,280 1,292	1.023	251.9 253.9
10.00	6.00	1583	6940.6	8.363	1.2752	1.1009	476	- 00067	2.151	363.4	2.138	1.262	310.6
20.00 40.00		1359	6698.7 6491.7	8.363	1.2894	1.0585	421 368	00057	2.548	383.9	3.327	1.393	343.0
100.00	•60	931	6264.8		1 2540	.9712	301	00038	3.492		9.918	1.601	394.2
200.00	•30 •15	784 657	6123.9	8 - 363	1.3366	.9436 .9230	255 214	- 00032	3.934	429.2 437.9	16.077 26.157	1.663	409.4
								00026					
2000-00	•06 •03	518 431	5878.1 5800.3		1.3573	.9026 .8928	168 139	00020	5.102	447.1 452.6	49.977 81.743	1.766	434.8
4000.0C	•02	358	5735.5	8.363	1.3600	.8833	113	00013	6.309	457.1	133.896	1.823	448.8
		г		= 0.450	, PERCE	NT FUEL	= 21+6	т	* 3.571				
1.00	60.00 57.14	2696	7354.5 7325.9	9 • 102 9 • 102	1.2326	1.1570	696 692	0.00099	0 • 0 0 0 2 8 2	558.6	2.188	0+000 +204	0 • 0 49 • 9
1.20	50.00	2604	7249.0	9.102	1.2344	1.1496	682	-00097	.548	354.0	1.269	•392	95.8
1.40	42.86 37.50	2529	7162.6	9.102 9.102	1.2360	1.1434	670 660	-00095	•750 •891	315.1	1.066	•529 •622	129.2
1.80	33.41	2411	7028.4	9-102	1.2388	1.1326	651 643	-00092	1.000	304.4	1.000	•690	168-4
2 • 0 0 4 • 0 0	30 • 00 15 • 00	2362	6972.2 6638.0	9 • 102 9 • 102	1.2401	1.1278	589	-00081	1.093	305.4 328.1	1.284	1.023	249-7
4.08	14.70	2053	6628.8	9.102	1.2493	1.0940	587	-00080	1.610	328.9	1.297	1.029	251.3
10.00	6.00 3.00	1710	6261.7	9 102	1.2637	1.0464	516 460	,00068 -00059	2.153	361.0	2.157 3.370	1.263	308 - 4
40.00	1.50	1266	5813.8	9.102	1.2911	.9682	405	.00050	2.938	399.0	5.380	1.500	366.1
100.00	•60	1024	5585.4		1.3112	.9199	334	- 00-04-0	3.474	417.1	10.154	1.607	392+3
200.00 400.00	•30 •15	866 729	5442.7 5322.2	9.102	1.3250	.8901 .8657	285 241	+00033 +00027	3.906 4.370	428.0 437.0	16.525 26.977	1.670	407.9 420.5
1000.00	•06	577	5192-1	9.102	1.3495	.8430	150	.00021	5.045	446.4	51.722	1.777	433.8
2000 • 00 •000 • 00	•03	481 401	5112.3 5045.7	9.102	1.3569	•8300 •8207	15B 129	.00017 .00014	5 - 609	452.0 456.7	84.764 139.079	1.809	441.7
	702	. ***					l	2, 0/F	. 1				
1.00	60+00	2828	6769.6			1.0967		0-00098	0.000		1	0.000	0.0
1.05	57.14	2802	6741.8	9.811	1.2270	1.0949	724	+00098	.283		2.184	• 204	49.2
1.20	50.00 42.86	2657	6582.8	9.811 9.811	1.2283	1.0899	714	00096	•550 •751	349.4	1.268	•392 •528	94.5
1.60	37.50	2591	6511.8	9.811	1.2311	1.0791	692	· 00092 • 00091	.893	302.2	1.011	.621	149.8
1.79 2.00	33.49 30.00	2484	6453.1 6397.2	9.811	1.2322	1.0749	684 675	+00091 +00089	1.096	300.6 301.6	1.000	•688 •746	166.0
4.00 4.08	15.00	2175	6070.5	9.811	1.2415	1.0411	622	•00080 •00080	1.599		1.288	1.022	246.6
								1					
10.00	6.00 3.00	1813 1571	5701.2 5463.9	9.811	1.2548	.9976	549 492	.00069	2.153	357.3 378.1	3.404	1.264	304.9
60.00	1.50	1354	5258.9		1.2806	9245	436	.00051	2.933		5.454	1.503	362.6
40.00			5033 6	9.811	1.3003	.8769	363	.00041	3.461	413.8	10.345	1.612	388.9
100.00	•60	1102	5031.6										
100.00	•30	936	4888.8	9.811	1.3150	.8455	312	•00034	3.885	424.9	16.895	1.677	404.5
100.00 200.00 400.00	•30 •15	936 790	4888.8 4767.9	9.811 9.811	1.3283	.8455 .8194	312 264	+00034 +00028	3.885	424.9	16.895 27.668	1.677	404.5 417.3
100.00	•30	936	4888.8	9.811	1.3150 1.3283 1.3426 1.3514	.8455 .8194 .7938 .7790	312	•00034	3.885	424.9 434.0 443.6 449.4	16.895	1.677	404+5

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(e) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	h.	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos - ity, #,	Thermal conductivity,	Mach number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	
P _c /P	No/sqin. abs	ĸ	cal/g	900	γ	C _p , cal/igH°Ki	micro	k, col/(secil*K)(cm)	M	I _{wac} ,	ε	C ^t	: L hbi(moci/ lb
		•i	L f	= 0.600	PERCE	NT FUEL	1,000	35, O/F	= 4.76	١	J	L	
1.00	60.00	3015	5841.6	11.142	1.2182	0.9956	777	0.00095	0.000			0.000	0.0
1.05	57.14	2989	5815.5	11.142	1.2186	.9942	773	•00094	.284	534.1	2.179	.203	47.7
1.20	50.00		5745.1	11.142	1.2197	.9901	763	•00093	•551		1.265	+391	
1.40	42.86 37.50	2838	5599.2	11.142	1.2210	.9853	751 741	+00091 +00089	•754 •896	293.2	1.064	•527 •620	123.6
1.79	33.59	2715	5545.4	11.142	1.2232	.9774	733	.00088	1.000	291.8	1.000	.685	160.5
2.00	30.00	2660	5491.2	11.142	1.2242	.9737		•00087	1.099	292.8	1.008	745	174.6
4.00	15.00 14.70		5182.6	11.142	1.2312	.9498 .9491	671 669	•00079 •00378	1.602	315.3	1,293	1.022	239.5
10.00	4 00	1963	4831.8	11.142	1.2426	.9136	598	•00068	2.155	347.8	2.192	1.265	296.4
20.00	3.00		4605.0	11.142	1.2533	.8826	541	•00060	2.543	368.5	3.452	1.399	328.0
40+00	1.50	1483	4407.9	11.142	1.2606	.8499	484	•00052	2.927	385.8	>.559	1.507	353+2
100.00	•60	1217	4187.7	11.142	1.2843	.8057 .7739	409 354	•00042	3.444	404.2	10.621	1.618	379.4
400+00	•30 •15	1041	3929.6	11.142	1.2995	.7464	303	•00035 •00029	4.295		28.712	1.740	407.9
1000.00	•06	707	3800.0	11.142	1.3311	•7170	242	•00023	4.931	434.5	55.548	1.798	421.5
2000-00	•03	594	3719.7	11.142	1.3414	•7007	202	•00019	5.465	440.4	91.527	1.833	429.7
4000.00	•02	497	3652.4	11.142	1.3504	-6874	168	•00015	6.048	445.3	150.804	1.862	436.4
			r	= 0.700	r · · · · · ·	NT FUEL			≠ 5•556	, 	r		
1.00	60.00 57.14	3128 3101	5138.3 5113.9	12.360	1.2132	0.9147	811	0.00090	0.000	516.6	2.176	0.000 .203	0 • 0 46 • 1
1.20	50.00	3029	5048.1	12.360	1.2146	.9101	797	.00089	.552	327.7	1.264	•390	88.6
1.40	42.86	2947	4974.0	12.360	1.2157	•9060	785	•00087	.755	292.0	1.063	•527	119.6
1.60	37.50	2678	4911.5	12.360	1.2168	.9024	775	•00085	.898 1.000	283.8	1.010	.619	140.5
1.78	33.66 30.00	2823	4861.9	12.360	1.2177	.8993 .8960	766 758	•00084 •00083	1.100	282.4	1.009		168.9
4.00	15.00	2439	4520.6	12.360	1.2249	.8755	704	■00076	1.604	305.4	1.296	1.021	231.8
4.08	14.70	2429	4512.6	12.360	1.2251	.8749	702	•00076	1.617	306.2	1.310	1.028	233.3
10.00	6.00	2055	4190.3	12.360	1.2353	.8440	631	•00066	2.156	337.2		1.265	287.2
40.00	3.00 1.50	1797 1564	3975.9 3788.9	12.360	1.2451	.8168 .7879	574 517	•00058 •00051	2.542	357.5 374.6		1.401	318 • 0 342 • 7
				_					3.434				
200.00	•60 •30	1291	3579.1 3445.6	12.360	1.2741	•7473 •7171	440 384	•00042 •00035	3.839	392.8 404.0	10.796 17.797		368.3 383.8
400.00	•15	946	3331.4	12.360	1.3040	•6897	331	•00029	4.269	413.2	29.399	1.747	396+5
1000.00	•06	760	3206+1	12.360	1.3224	•6595	266		4.890	423.0	57.120	1.806	410-0
4000.00	•03 •02	640 537	3128.2	12.360	1.3341	.6420 .6280	186	•00019 •00015	5.410	428.9	94.365	1.842	418.2 425.0
		1		= 0.800	l	NT FUEL	= 13.6		= 6=349	l		.	
1.00	60.00	3188	4586.9	13.470	1.2103	0.8490	835	0.00086	0.000			0.000	0.0
1.05	57.14	3161	4564.0	13.470	1.2106	.8480	831	•00086	.285	499.6	2.174	.203	44.6
1.20	50.00	3088	4502.5	13.470	1.2115	.8451 .8415	821	•00084 •00083	•553 •756	317.0	1.263	•390 •526	85.7 115.6
1.60	42.86 37.50	3006 2936	4374.7	13.470	1.2136	8382	798	•00082	.899	274.6	1.010	.618	135.9
1.78	33.69	2881	4326.7	13.470	1.2144	.8356	790	-00081	1.000	273.3	1.000	+682	149.9
2.00	30.00	2823	4279.9	13.470	1.2154	.8326 .8143	781 727	•00079 : •00073	1.101	274.3	1.009 1.298	1.021	163.4 224.4
4.00	15.00 14.70	2484	4000.4	13.470	1.2215	.8137	725	•00072		296.4	1.312	1.028	225.8
10.00	6.00	- 2106	3698.1	13.470	1.2311	.7860	654	•00063	2.156	326.7	2.212	1.266	278.1
20.00	3.00	1845	3496.4	13.470	1.2402	.7617	597	•00056		346.5	3.499 5.664	1.402 1.511	308 • 0
40.00	1.50	1609	3319.9	13.470	1.2509	.7355	539	•00050				1.511	332.0
200.00	•60 •30	1333	3121.5 2994.8	13.470	1.2824	.6980	462	•00041 •00035		381.0	10.902 18.014	1.625	357•1 372•2
400.00	•15	982	2886.1	13.470	1.2975	•6434	350	•00029	4.254		29.828	1.751	384.7
1000.00	•06	792	2766.6	13.470	1.3154	.6138	284	•00023	4.865	410.8	58.120	1.811	398.0
2000.00	•03	669	2692.0	13.470	1.3290	.5960 .5819	239 400	•00019	5.377 5.937	416.6	96.197 159.100	1.848	406.1
4000+00	•02	562	2629.2	13.470	1.3397	L		•00015			133,100	1.070	41201
			R 4142.9	= 0.900 14.479		0.7951		0.00082	0 • 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0			0.000	0.0
1.00	60.00 57.14	3186	4142.9	14.479	1.2086	.7942	848	•00082	.285	483.8	2.173		43.2
1.20	57.14 50.00 42.86	2112	4063.8	14.479	1.2098	.7915	637	10000	• 253	207.0	1.263	.390	83.0
1.40	42.06	3031		14.479	1.2108	• 7883	825	•00079	•757 •899	473.6	1.063	.526 .618	112.0
1.60	37.50 33.72		3943.9 3901.1		1.2118	• 7825 • 7829	909	•00078 •00077	1.000	266.0 264.7	1.010		145.1
2.00	30.00	2848	3854.9	14.479	1.2135	.7802	797	•00076	1.102	265.7	1.009	.744	158.3
4.00	15.00 14.70	2518	3600.0 3592.9	14.479	1.2192	•7634 •7629	742	•00069 •00069	1.606 1.619	286.5 287.2	1.299	1.021	217.4
i												1.266	
10.00 20.00	6.00 3.00	1800		14.479	1.2014	•7374 •7153	569 511	•00061 •00054	2.156	316.7 335.9	3.509	1.402	298.6
40.00		1632		14.479	1.24/0	•0310	فؤو	•0004B	2.919	352.2	5.686		321.9
		1354		14.479	1.2044	.6562	476	•00-)39		369.6	10.964	1.626	346.3
100.00		1166			1.2/06	.6299	418	•00034		380.3	18.140	1.696	361.0
200.00	• 30	. 1200	2047	444712				00010	4.30.6		30 040		172. 3
200.00 400.00	•15	1001		14.414	1.2916	-6048	ۇ ھۇ	•00028	4.245	389.2	30.080	1.753	_
200.00	•30 •15 •06 •03	1001 809 684	2542.1 2428.7 257.8	14.479		•6048 •5762		•00028 •00022 •00018	4.245		30.080 58.719 97.311		373.2 386.2 394.1

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSI(NED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(e) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute; frozen composition during isentropiceexpansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy, h,	weight,	Isentropic exponent,	Specific heat,	Viscos - ity, µ,	Thermal conductivity,	HUMBER	Specific impulse in vacuum,	Area ratio,	Thrust coefficient	Specific impulse I.
P _c /P	No/sqin. abs	°K	col/g	900	γ	C _{p.} col/(g)(^o K)	micro poises	k, cal/(sec)(^D K) cm	M	I _{voc,} (lb)(sec)/lb	ε	C,	(lb)(sec)/(
		L		R = 1.000	L	ENT FUEL	1.5	19. O/F	= 7.93	1	L	L	
!			_	r		T	1		1	i	T	T	I
1.00	60 • 00 57 • 14	3217	3777.9 3757.7	15.399	1.2077	0.7503	864 860	0.000.9	0.000	469.4	2.173	0.000 -203	
1.20	50.00	3118	3703.4	15.399	1.2088	.7470	849	•000 7	-554	297.9	1.262	+390	80.
1.40	42.86 37.50	3036 2966	3642.1 3590.4	15.399	1.2108	.7439 .7412	837 826	•000 5	•757 •899	265.5 258.1	1.063	•526 •61¢	108.
1.60	33.73	2912	3550.2	15.399	1.2116	.7389	018	•00074	1.000	256.9	1.000		140.
2.00	30.00	2853	3506.7	15.399	1.2125	.7364	808	+00073	1.102	257.9	1.009	•743	153.
4.00	15.00 14.70	2523 2514	3266.5 3259.8	15.399	1.2181	•7207 •7202	753 751	•00066	1.606	278.1	1.300		210.
10.00	6.00	2135	2991.6	15.399	1.2274	.6965	678	•00058	2.156	307.4	2.218	1.266	261.
20.00	3.00	1875	2812.4	15.399	1.2360	.6759	621	•00012	2.541	326.2	3.515	1.403	289.
40.00	1.50	1638	2655.5	15.399	1.2462	•6532	562	•000+6	2.919	341.9	5.698		312.
100.00 200.00	•60 •30	1361 1175	2478.5	15.399 15.399	1.2025	•6207 •5960	485 427	•00038 •00032	3.424	359.0 369.4	10.997 18.208	1.627	336. 350.
400-00	.15	1008	2267.8	15.399	1.2912	•5/22	374	•000∈7	4.241	378.1	30.218	1.754	362.
1000-00	•06	815	2160.3	15.399	1.3103	.5449	304	•000.1	4.844	387.4	59.055	1.816	375.
2000+00 4000+00	•03 •02	690 581	2093.1	15.399	1.3235	-5280 -5145	258 217	•000 B	5.347	393.0	97.944	1.853	382.
4000400		, ,,,,		= 1.500	l	NT FUEL	į.		*11.90	L	1	1	
		2226		T		Τ				1			
1.00	60 • 00 57 • 14	3116 3090	2626.1 2610.2	18.987 18.987	1.2082	0.6073 .6065	889 884	0.000 6 .000 5	0.000 .285	416.0	2.173	0.000 .203	37.
1.20	50.00	3019	2567.5	18.987	1.2094	+6044	873	●00014	•553	264+0	1.263	•390	71.
1.40	42.86	2939 2872	2519.5	18.987	1.2105	•6019 •5996	848	•000±3	.757 .899	235.3	1.063	.526 .618	96.
1.60	37.50 33.72	2819	2478.9	18.987	1.2115	•5977	839	+00052 +00051	1.000	227.6	1.000	.681	124.
2.00	30.00	2762	2413.1	18.987	1.2132	•5956	829	•00000	1.102	228.5	1.009	.744	136.
4+00 4+08	15.00 14.70	2442	2224.5	16.987	1.2189	.5828 .5824	770	•00055 •00055	1.606	246.4	1.300		186.
i	_												
10.00 20.00	5.00 3.00	2066	2008.8 1868.3	18.987	1.2282	•5633 •5466	632	•000° B	2.542	272.3	2.217 3.511	1.266	231.
40.00	1.50	1584	1745.2	18.987	1.2467	•5289	573	•000 B	2.920	302.9	5.691	1.512	276.
100.00	•60	1315	1606.5	18.987	1.2624	.5035	495	•000:1	3.425	318.0	10.982	1.627	297.
200.00	•30	1136	1517.7	18.987	1.2757	.4843 .4658	439	•000-7	3.824 4.244	327.2	18.188 30.198	1.696	310.
400.00	•15	975	1441.2	18.987	1.2898	14020	384	•000.3	4,244		30.198	1.754	321.
1000.00	•06	789	1356.9	18.987		-4442	317 271	•000 B	4.846 5.347	343.1	59.073 98.060	1.615	332.
2000.00 4000.00	•03 •02	669 564	1304.1 1259.5	18.987	1.33212	.4305 .4190	230	•000 5 •000 3	5.896	352.3	162.595	1.852	344.
			R	= 2.000	• PERCE	NT FUEL	= 5.9	27. O.F	 -15•87	1	L	1	L
1.00	60.00	2966	2016+0	21.453	1.2116	0.5304	886	0 • 0 00: 7	0.000			0.000	0.
1.05	57.14	2941	2002.7	21.453	1.2119	.5297	882	•000 7	•284	381.8	2.175	.203	34.
1.20	50 • 00 42 • 86	2873 2796	1966.7	21.453	1.2129	•5277 •5253	870 856	•000°6	•553 •756	242.3	1.264	. 526	65 • 88 •
1.60	37.50	2731	1892.1	21.453	1.2151	.5232	844	•000 4	.898	209.8	1.010	.619	103.
1.78	33.68	2679	1865.1	21.453	1.2160	•5215	834	•00013	1.000	208.8	1.000	•683	114.
2.00	30.00 15.00	2625 2316	1836.7	21.453	1.2169	.5196 .5079	824 763	•000° 2 •000° 8	1.101	209.6	1.009	.744 1.021	124.
4.00	14.70	2308	1673.9		1.2232	.5076	761	•000-7	1.618	226.4	1.311		172.
10.00	6.00	1954	1497.4	21.453	1.2327	•4906	682	•000-1	2.156	249.5	2.208	1.265	212.
20.00	3.00	1711	1379.8	21.453	1.2416	.4/60	624	•000:7	2.543	264.6	3.492	1.401	235.
40+00	1.50	1492	1277.1	21.453	1.2517	.4607	56∠	•000: 2	2.923	277.3	5.650	1.510	253.
100.00 200.00	•60 •30	1236	1161.6	21.453	1.2671	.4394	486	•000.7 •000.3	3.433	290.9 299.3	10.878	1.624	272.
400.00	•15	912	1024-5	21.453	1.2935	.4082	378	•000.0	4.259	306.2		1.750	293.
1000.00	•06	737	954.7	21.453	1.3114	.3901	313	•000 6	4.868	313.7	58.249	1.810	303.
2000.00	•03	624	911.1	21.453	1.3241	.3764	269	•000.3	5.374	318.2	96.601	1.847	310.
4000+00 j	•02	525	874.3	21.453	1.3358	.3685	229	•000 1	5.927	321.9	160.027	1.877	315.
,		,	R	= 3.000	• PERCE			31 • 0. F) 	r		
1.00	60.00	2655	1381.4	24.532	1.2209	0.4476	851	0.000.7	0.000	227.5	, ,,,,	0.000	30•
1.20	57.14 50.00	2632 2569	1371.0	24.532	1.2213	•4470 •4452	847	•000.6	•283 •551	337.8 214.2	2.181	•204 •391	30 · 57 •
1.40	42.80	2498	1311.2	24.532	1.2237	•4430	620	*000·>	•753	190.8	1.064	-528	78.
1.60	37.50	2437	1284.5	24.532	1.2249	.4411	807	•00014	-895	185.4	1.010	-620	91.
1.79	33.56	2386	1262.6	24.532	1.2270	•4395 •4378	797 787	+000±3	1.000	184.4	1.000	.686 .745	101.
4.00	30 • 00 15 • 00	2339	1241.4	24.532	1.2340	•4378	723	•000° 2		199.2	1.008	1.022	151.
4.08	14.70	2046	1114.8	24.532	1.2342	.4269	721	•000.8	1.615	199.7	1.305	1.028	152.
10.00	6.00	1721	978.3	24.532	1.2448	.4119	641	+000:3	2.155	219.7	2.187	1.264	187.
20.00	3.00	1499	888.0	24.532	1.2540	•3999	581	•000:9	2.546	232.7	3.443	1.399	207.
40.00	1.50	1300	809.6	24.532	1.2646	.3672	523	•000:6	2.931	243.6	5.545	1.506	223.
100.00	•60	1068	721.9	24.532	1.2800	.3703	450	•000.1	3.451	255.3	10.611	1.617	239.
200+00	•30	916	600.3	24.532	1.2924	•3500	398	•000.8	3.863	262.4	17.467	1.684	249.
400-00	•15	781	618.8	24.532	1.5026	•3460	349	•000.6	4.298	268.3	26.839	1.739	257.
1000-00	•06	627	566.7	24.532	1.5230	•3318	284	4 000. غ	4.924	274.5	56.029		266.
2000-00	£0•	528	534.3	24.532	1.3555	*3224	249	•000. l		276.3	92.556		271.
4000•00	•02	443	507.2	24.532	1.3473	.3142	212	•0000	6.016	281.5	152.735	1.862	275.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(e) Concluded. Combustion-chamber pressure, 60 pounds per square inch absolute; frozen composition during isentropic expansion

		T, °K	h, cal/g	weight, 971	Isentropic exponent,	heat, c _{p,} col/(g)(°K)*	ity, μ, micro poises	Thermal conductivity, k, cal/(sec)(°K)(cm)	Mach number M	impulse in vacuum, I _{vac} , (lb)(sec)/lb	Area ratio, £	Thrust coefficient, C _F	Specific impulse I, (lb)(sec)/(
	L.a			R = 4.000	PERCE	NT FUEL		054 • O/F	×31 • 741		1	L	L
1.00	60.00	2347	1054.4	26.257	1.2321	0.4017	798	0.00040	0.000	i		0.000	0.
1.05	57.14 50.00	2326	1045.8	26.257	1.2326	.4010 .3992	794 781	•00039 •00039	•282 •548	306.9 194.5	2.188 1.269	•204 •392	27. 52.
1.40	42.86	22.02	996.5	26.257	1.2355	.3971	766	•00038	•750	173.1	1.066	• 529	71.
1.60	37.50 33.42	2147 2100	974.5 956.0	26.257	1.2368	•3953 •3937	754 743	•00037 •00036	1.000	168.2	1.011	•621 •690	83. 92.
2 • 00	30.00	2057	939.0	26.257	1.2391	•3922	733	•00036	1.094	167.8	1.008	• 747	100-
4.00 4.08	15.00 14.70	1796 1789	838.1 835.3	26.257	1.2469	•3822 •3819	669 667	•00032 •00032	1.598	180.7	1.285 1.298	1.023	137.
10.00 20.00 40.00	6.00 3.00 1.50	1493 1292 1113	724.3 651.4 588.3	26.257 26.257 26.257	1.2565 1.2684 1.2793	•3685 •3577 •3467	588 530 475	•00027 •00024 •00021	2.155 2.549 2.941	198.5 210.0 219.6	2.162 3.387 5.428	1.263 1.396 1.501	169. 187. 201.
100.00	•60	908	518.5	26.257	1.2950	.3323	406	•00017	3.471	229.8	10+316	1.610	215.
200•00 400•00	•30 •15	773 655	474.5 437.1	26.257 26.257	1.3079 1.3212	•3215 •3113	357 312	.00015 .00013	3.893 4.342	236.0 241.1	16.892 27.741	1.674 1.728	224. 231.
1000•00 2000•00 4000•00	•06 •03 •02	522 437 364	396.4 371.3 350.4	26.257 26.257 26.257	1.3386 1.3510 1.3601	•2992 •2913 •2859	258 221 187	*00010 *00009 *00007	4.990 5.531 6.129	246.5 249.7 252.3	53.515 87.939 144.427	1.784 1.817 1.845	239. 243. 247.
				= 5.000		NT FUEL			=39.683	L			
1+00	60.00	2062	855.0	27.299	1.2440	0.3711	740	0.00034	0.000	303	2 10-	0.000	.0-
1.05	57.14 50.00	2042 1989	847.7 828.1	27.299 27.299	1.2445	•3705 •3688	735 722	•00034 •00033	•281 •546	282.0 178.6	2.195 1.272	• 205 • 394	25. 48.
1.40	42.86 37.50	1929 1879	806.1 787.6	27.299 27.299	1.2476 1.2491	.3668 .3650	708 696	•00032	•747 •888	158.9 154.3	1.068	.531	65.
1.80	33.28	1835	771.5	27.299	1.2505	•3634	684	•00032 •00031	1.000	153.4	1.012	■623 ■694	76. 85.
2.00 4.00	30.00 15.00	1797 1560	757.8 673.2	27.299 27.299	1.2517	.3620 .3528	675 612	•00031 •00027	1.090	153.8 165.1	1.007 1.279	1.024	92. 125.
4-08	14.70	1554	670.9	27.299	1.2603	.3525	610	•00027	1.607	165.4	1.292	1.030	126.
10.00 20.00 40.00	6.00 3.00 1.50	1287 1107 948	578.5 518.2 466.4	27.299 27.299 27.299	1.2725 1.2830 1.2943	.3399 .3300 .3201	534 479 427	•00023 •00020 •00018	2.154 2.553 2.950	181.4 191.7 200.2	2.138 3.333 5.313	1.262 1.393 1.496	155. 171. 183.
100.00 200.00 400.00	•60 •30 •15	766 648 545	409.5 373.8 343.8	27.299 27.299 27.299	1.3111 1.3244 1.3380	•3068 •2972 •2881	363 317 276	•00014 •00012 •00010	3.491 3.924 4.387	209.2 214.6 219.1	10.027 16.328 26.662	1.602 1.665 1.716	196. 204. 210.
000.00	•06	431 359	311.4 291.5	27.299 27.299	1.3550	•2779 •2726	226 192	•00008 •00007	5.058	226.6	51.055 83.484	1.770	217.
4000+00	•02	298	275.0	27.299	1.3704	•2693	162	•00006	6.250	228.8	136.601	1.828	224.
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TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OKYGEN

(f) Combustion-chamber pressure, 150 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio, P _c /P	Static pressure, P, Ib/sqin	Temp- erature, T, "K	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos - ity, #, micro	Thermal conductivity, k,	Mach number M	Specific impulse in vacuum, I _{vac}	Area ratio, E	Thrust coefficient C _F	Specifi impuls I, ibilise:/
	abı .			L	i. •	col/(g)(°K)	poises	cal/(secH°K)(cm)		(lbiiseci/lb		j	1 101 100:1/
			f	0 = 0 - 150	. PERCE	NT FULL	= 45.	65. O/F	1 1 1 1 9			,	
1.00	150.00	1183	5313.5	4.416	1.3396	1.7753	314	0+00073	0.000			0.000	0.
1.05	142.86	1168	5287.7	4.416	1.3406	1.7710	311	•00073	271	530.1	2.250		47.
1.20	125.00	1129	2218.6	4.416	1.3436	1.7597	305	•00070	•527	334.2	1.297	.403	90
1.40	107.14	1000	2141.8	4.416	1.3469	1.7472	293	•00068	•722		1.051	.543	122
1.60	73.75	1049	5077.7	4.416	1.3497	1.7369	285	•00066	.860	∠85.6	1.018	.636	143
1.67	80.42	1009	2006.8	4.410	1.3528	1.7257	276	•00063 •00062	1.000	284.1	1.000	• 725 • 761	163
4.00	75.00 37.50	989 824	4975.4	4.416	1.3651	1.6825	234	•00052	1.566	301.7	1.233	1.031	232
10.00	15.00	643	4392.5	4.416	1.3746	1.6505	188	+00042	2.152	327.5	1.974 1.997	1.257	283 284
10.21	14.70 7.50	532	4386.6 4209.8	4.416	1.3750	1.6501	159	+00041	2.586	343.5	2.982	1.376	309
20.00 40.00	3.75	439	4058.9	4.416	1.3824	1.6268	133	•00029	3.031	356.4	4.620	1.467	330
			•	Ì				1					
100.00	1.50	340	3899.0	4.416	1.3882	1.6093	104	•00023	3.648	369.8	8.432	1.558	
200.00	.75	280	3802.6	4.416 4.416	1.3926	1.5961	70	*00018 *00015	4.149	377.7	13.431	1.610	362 372
400.00	• 30	230	3123.2	. ***10	114000	1.0000	, ,	*00012	44012	30741	21,400		
000.00	.15	175	2640.1	4.416	1.4349	1.4847	55	•00011	5.438	390.6	39.928	1.694	381
000-00	•00	142	3590.9	4.416	1.4520	1.4389	45	•00009	6.096	394.3	63.572	1.719	387
000.00	•04	114	3551.2	4.416	1.4/05	1.4065	36	•00007	6.845	397.3	100.938	1.739	391
			F	0.200	PERCE	NT FUEL	= 38.	65, U/F	1.587	7			
1.00	150.00	1514	2969.7	5.216	1.3079	1.6183	402	0.00084	0.000			0.000	o
1.05	142.86	1497	2941.7	5.216	1.3090	1.6140	399	•00083	.274	552.2	2.233	.209	49
1.20	125.00	1450	2860.8	5.216	1.3120	1.6022	389	•00.381	•533 •730	348.6	1.289	•400 •539	94 127
1.40	93.75	1398	2783.2	5.216	1.3155	1.5887	369	•00078 •00076	.869	299.6	1.016	.632	149
1.60	01.23	1354	2640.5	2.216	1.3217	1.5651	359	+00073	1.000	297.3	1.000	.716	169
2.00	75.00	1282	2601.1	5.216	1.3236	1.5584	35.3	+00072	1.068	297.8	1.004	.757	179
4.00	37.50	1079	2290+0	5.216	1.3391	1.5046	307	•00061	1.572	316.7	1.244	1.029	243
10.00	15.00	852	1954.3	5.216	1.3006	1.4516	251	•00048	2.148	344.7	2.009	1.257	. 297
10.21	14.70	847	1947.7	20210	1.3504	1.4206		+00048	2.161	342.3	2.033	1.261	298
20.00	7.50	709	1748.8	5.216	1.3026	1.4232	213	•00040	2.573	362.0	3.049	1.379	325
40.00	3.75	588	1576.0	5.216	1.3715	1.4066	179	•00034	3.010	376.0	4.739	1.472	- 348
100.00	1.50	456	1396.3	5.216	1.3771	1.3913	142	•00026	3.619	390.5	8.679	1.565	370
200.00	.75	379	1286.2	5.216	1.3611	1.3807	117	•00022	4.111	399.1	13.870	1.619	362
400.00	• 3 8	312	1195.2	5.216	1.3861	1.3677	96	-00018	4.638	406.1	22.295	1.662	592
000.00	•15	: : 242	1099.0	5.216	1.3975	1.3400	74	.00013	5.394	413.4	41.979	1.706	403
00.00	.08	198	1041.1	5.216	1.4156	1.2977	61	.00011	6.014	417.6	67.687		409
000.00	•04	161	993.9	5.216	1.4320	1.2568	>0	•00009	6.704	421.1	108.754	1.754	414
•		*		= 0.250	PERCE	NT FUEL	= 33.	51, O/F	1.984	•			
					T	I	481	I ia.		·			Ι.
1.00	150.00	1816	1249.3	0.016	1.2835	1.4955	477		0.000	563.4	2.219	0.000	50
1.20	142.86	1744	1142.1	6.016	1.2070	1.4012		•00001	ە <i>د</i> د.	356.1	1.283	398	96
1.40	10/.14	1685	1054.8	6.016	1.2700	1.4693	450	.00000	.736	316.3	1.073	. > 30	130
1.60	93.75	1630	981.5	6.016	1.2927	1.4590	446	•00083	.876	306.6	1.015	•629	152
1.83	61.95	1586	910.0	6.016	1.2954	1.4485	436	•00001	1.000	304.5	1.000	-708	171
2.00	75.00	1554	864.0	6.016	1.2973	1.4415	429	00000	1.076	305.1	1.005	1.027	183
4.00	37.50	1322	535.3	6.016	1.3125	1.3073	3/0	•00068	1.370	369.3	1.270	1.02	277
10.00	15.00	1057	176.5	6.016	1.3330	1.3225	314	•00054	2.147	355.3	2.048	1.258	305
10.21	14.70	1052	169.3	0.016	1.3904	1.3212	314	+00054	2+159		2.072	1.263	306
20.00	7.50	867	9954.4	6.016	1.5401	1.2048	269	+00046	2.263	373.6	3.127 4.883	1.382	3 5 5 5 5 6
40.00	3.75	740	9768.6	b+016	1.3209	1.2559	220	•00038	2.707	30040	4.003	1.410	330
100.00	1.50	200	9569.7	6.016	1.3603	1.2520	181	•00000	3.581	404.1	8.985	1.575	382
200.00	.75	461	9448.5	6.016	. 1.5/17	1.2191	151	+000€5	4.064	413.3	14.395	1.650	395
400.00	.38	399	9348.0	6.016	1.3705	1.2100	124	+00040	4.082	420•8	23.206	1.675	406
000.00	.15	310	9241.3	5.016	1.3821	1.1948	95	-00015	5.327	428.7	43.889	1.722	418
000.00	.08	256	9176.7	6.016	1.3865	1.1805	78	•00012	5.945	433.3	71.271	1.749	424
000.00	•04	210	9123.6	6.016	1.4039	1.1482	64	+00010	6.606	437.1	115.634	1.771	430
	L	L	ــــــــــــــــــــــــــــــــــــــ	. = 0.300	PERCE	NT FOEL	= 29.	1 57, 0/F	2 • 38	L		1	1
		3600	9932.7				~	Т				0.000	0
1.00	150.00 142.86	2071	9932.1	6.813	1.2648	1.3901	246	•00096	.278	568.3	2.208	.206	50
1.20	125.00	2013	9823.6	6.013	1.26/6	1.3814	> 36	•00094	.542	359.6	1.278	.396	97
1.40	107.14	1949	7/34.5			1.3711	224	•00091		319.6	1.071	-533	
1.60	93.75		9659.7		1.2725	1.3019	514 204		180.	310.0	1.013 1.000		
2.00	75.00	1805	9590±2	0.013	1.2765	1.3465	497	•00000	1.082	30001	1.006		
4.00	37.50	1549	9200.9			1.2976		•00074				1.025	
							1				1 24		91+
10.00	15.00	1254	8827.4		1.3099	1.2329		•00050		361.4 362.1	2.084 2.110	1.260	310 311
20.00	14+70	1248	8817.7		1.3103	1.2315		•00050	2.555	380.8	3.204		341
	3.75	1001	8396.8	6.815	1.3387	1.1527		•00044	2.969	396.6	5.034		
40.00			ļ.										
	1	700	8184.1	6.813		1.1172				415.0		1.584	
40.00 100.00	1.50		8053.8	6.813	1.3500	1.1005		•00027		422.8 430.6		1.642	
40.00 100.00 200.00	• 75	588	1965 4		1 . 4000	Lanna	155						
40.00 100.00		400	1942.5		1.3000	1.0000	150	•00023					
40.00 100.00 200.00	•75 •38	400	1945.5	6.613	1.3720	1.0/42	120	-00017	2.769	414.1	42.957	1.738	427
40.00 100.00 200.00 400.00	•75 •38 •15	310	1942.5 1829.0 7759.4	0.013		1.0/45	120	•0001/ •00014	2.769	414.1		1.738	427

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNEDPPRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(f) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	h,	Molecular weight,	exponent,	Specific heat,	Viscos - ity, μ,	Thermal conductivity, k,	Mach number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	Specific impulse I
P _c /P	1b∕sqin orbs	"K	cal/g	200	γ	cal/ g);"K	micro poises	cal/isecii ⁿ Ki(cm)	M		ε	C ^t	(lb)(sec)/(
		l :	н	= 0.350	PERCE	NT FUEL		47, 0/F	= 2.77			L	
1.00	150.00	2339	8892.8	7.604	1.2505	1.3047	610	0.00099	0.000			0.000	0.
1.00	142.86	2310	8563.1	7.604	1.2511	1.3020	606	•00099	.280	569.0	2.199	205	50.
1.20	125.00	2254	8783.4	7.604	1.2529	1.2946	596	•00097	.544	360.3	1.274	. 394	97.
1.40	107.14	2100	8693.9	7.604	1.2551	1.2859	584	•00094	. 745	320.4	1.069		131.
1.60	93.75 82.97	2074	8618.7	7.004	1.2570	1.2784	574 564	•00092 •00090		311.0	1.012		154
2.00	75.00		8497.5	7.604	1.2002	1.2006	556	•00000	1.087	310.0	1.007		185
4.00	0 خ ۰ 7 د	1756	8154.9	1.604	1.2720	1.2223	205	•00078		332.2	1.274		253.
				3	1.2899	1 16 47		•00064	2.150	364.4	2.115	1.261	312
10.00	15.00	1436	7773.7	7.604	1.2904	1.1014	431	•00064	2.162	365.0	2.142		313.
20.00	7.50	1225	7532.9		1.3020		377	•00055	2.551	384.5	3.274	1.390	344.
40.00	3 • 75	1039	7328.2	7.604	1.3202	1.0774	326	-00046	2.955	401.0	5.175	1.491	369
100.00	1.50	6∠8	1105.5	7.604	1.3377	1.0353	264	•00036	3.514	418.2	9.648	1.594	394.
200.00	. 75	694	6968.0	7.604	1.3485	1.0112	223	•00030	3.969	428.5	15.575	1.654	409
400.00	• ±0	579	6853.0	1.604	1.3563	.9948	166	•00025	4.459	436.9	25.259	1.703	421
1000-00	•15	454	6729.9	7.604	1.3642	.9790	146	•00019	5.169	445.7	48.098	1.753	433.
2000.00	•00		6624.8	7.604	1.5092	.4643	119	•00015	5.760	451.0	78.522	1.783	441.
•000•00	• 0 4	512	0592.5	7.604	1.3/42	•9598	97	•00012	6.403	455.3	128.377	1.808	447.
			R	= 0.400	PERCE	NT FUEL	× 23.9	5, 0/F	= 3 • 17	·		· · · · · · · · · · · · · · · · · · ·	
1.00	150.00	2553	0050•5	8.379	1.2395	1.2276	660	0.00101	0.000			0.000	0.
1.0>	142.80	2524	0021.1	0.379	1.2400	1.2254	656	•00100	•281 •547	358.9	2.192	• 205 • 393	50 ·
1.20	125.00	2464 2391	7942•1 7653•3	8.379 8.379	1.2415	1.2192	646	•00098 •00096	.748	319.3	1.067	•530	131
1.40	93.75	2329	7778.6	0.379	1.2400	1.2052	624	•00094	.889	310.1	1.012	•623	153.
1.80	83.31	2276	7714.2	8.379	1.2465	1.1992	615	•00092	1.000	308.3	1.000	•692	
Z•00	75.00	2229 1938	7658.0	8.379	1.2479	1.1938	607 553	•00080	1.091	309.2	1.007 1.280	1.023	252
4.00	37.50	1930	/316.0	0.517	1.2310	1.1570	3,7,7	•00000				_	
10.00	15.00	1599	6932.6	8 - 379	1.2738	1.1033	480 479	•00067 •00067	2.152	364.8	2.141 2.168	1.262	311.
20.00	7.20	1592	6924.9		1.2742	1.1021	425	*00000	2.548	305.4	3.332		344
40.00	3.75	1173	6479.7	8.379	1.3030	1.0200	371	•00049	2.944	402.4	5.298	1.496	369
100.00	1.50	943	6250+6	6.579	1.3224	.9728	40د	•00039	3.490	420.3	9.946	1.604	395
200.00 :		794	6108.2		1.3321	.9448	458	-00032	3.931	431.0	16.131	1.664	411
400.00	• 38	666	5988.4	8.379	1.3405	.9235	217	•00026	4.406	439.8	26.255	1.714	423.
1000.00	•15	525	5859.6	8.379	1.3502	•9029	170	•00020	5.095	449.0	50.189	1.767	436.
2000.00	•08	437	578Q∙8	8.379	1.3517	.8928	141	-00017	5.672	454.5	82.113	1.799	444.
4000.00		363	5715.2	8.379	1.3670	ı	115	-00014		1 . :	134.543	1.024	450.
		,	R	= 0.450	PERCE	NT FUEL	≈ 21•6	37, J/F	= 3.57	1			т
1.00	150.00	2733		9.133	1.2310	1.1595	701		0.000	561.5	2.187	0.000	50
1.00	142.66		7325.6	9,133	1.2315	1.1576	698 688	•00100	.282	355.9	1.269	392	96
1.40	122.00 107.14	2640	7160.6	9.133	1.2328	1.1459	676	•00096	.750		1.066	.529	129
1.60	93.75	2500	7087.1	9.133	1.2378	1.1404	666	+00094	.892	. 307.7	1.011	•621	152
1.79	83.50	2446	7025.3	9-133	1.23/1	1.1355	657	•00092			1.000	•689	169
2.00	75.00	2395	6968.2	9.133	1.2303	1.1307		•00091		307.0	1.008 1.285	1.023	183
4.00	37.50	2092	6630.2	9.133	1.2471	1.0982	כלכ	•000e5	1.597	329.9	1,205	1.025	231
10.00	15.00	1738	6249.2	9.133	1.2614	1.0500	522	•00069	2.153	363.2	2.161	1.263	
10.21			6241.5	9.133	1.2617	1.0489	521	•00069	2.165	363.8 384.1	2.189 3.379	1.268	311
20.00 40.00	7.50 3.75	1501	6005.3 5795.1	9.133	1.2741	9720	467 411	•00060 •00051	2.937	401.5	5.399	1.500	368
40.00	3.13	1207							i				
100.00	1.50	1045	5563.1 5417.9		1.3084	.9231 .8924	341 291	•00041 •00034	3.471	419.9	10.202	1.608	394
400.00	.75	885 745	5417.9	9.133	1.3224	.8924	246	•00020	4.362	440.0		1.724	423
										449.5	52.106	1.779	436
1000.00	•15	570 473	2081.2	9+133 9+133	1.34/5	.8438 .8300	194	*00018	5.033 5.033	455.2	52.100	1.812	444
2000+00 : 4000+00		410	5013.2	9.133	1.3008	.8207			6.207	460.0	140.269	1.838	451
			L	 = 0+500		l Ent fuel	= 20•		= 3.96	↓ 8	·	L	1
		,	5769.6		1.2244		736	0.00099		T		0.000	0.
1.00	150.00 142.86					1.0981		+00099	.283	554.9	2.183	• 204	49
1.20	125.00	2705	6665.5	9.859	1.2260	1.0932	722	•00097	• >50	351.8	1.267	.392	95
1.40	107.14		6580.2		1.22/5	1.0875	710	•00095	.752	313.3	1.065		
1.60	93.75	2641	6508.2	9.859 9.659		1.0824	700	•00093	1.000	304.4	1.011		
1.79 2.00	03•79 75•00		6447.1 6391.9	7.007	1.2310	- 1.0/41		+00091	1.096	8.606	1.008	. 746	181
4.00	3/+20		6060.2		1.2309	1.0452		+00004	1.600	326.8	1.289	1.055	248
.0•00	12.00	1854	2684.8	! 9•859	1.2517	1.0024	250	•00070	2.154	: 360.2	2.177	1.264	307
10.21	14.70	1840	2677•i	9.009		1.0014	556	•00070	2.166	360.6	2.205	1.266	308
∠0•00	7.50	1004	2441.4	ジ・ゼラゲ	1.2003	•9670	504	-00061	2.545		3.416		
40.00	5.72	1300	2234.1	7.059	1.2708	.9297	445	•00053	2.732	398.8		;	
100.00	1.50	1132	2001.9		1.2904		. 37∠		3.457			1.613	
200.00	• 75	963	4655.6	9.859	1.31.2	.8493	320	•00035		428.8			408
400.00	•30	912	4/31.6	9.059	1.0647	.0223	272	•000∠9	4.328	438.1	21.924	1.732	1 721
		1		I	1 4406	.7953	215	•00023	4.982	447.9	53.794	1.789	
1000.00	•10	640	4591.2	9.839	1 . 3 2 7 3	1773							
	•15 •06 •04	545		9.839	1.3400	.7799	180	*00019	5.529	453.8		1.822	443

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OX GEN

(f) Continued. Combustion-chamber pressure, 150 pounts per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	weight,	Isentropic exponent,	Specific heat, c _p ,	Viscos- ity, 44,	conductivity	HOHIDEL	Specific impulse in vacuum	Area ratio,	Thrust coefficient	
ę/P	lb/sqin. obs	°K	cot/g	900	γ	cal/(g)(°K)*	micro poises	k, cal/(sec)(°K) cr	, M	I voc.	E	c,	(lb)(sec)
			1	R = 0.600	D. PERC	ENT FUEL	= 17.	35, O/F	= 4•76	2			
1.00	150.00	3097	5841.5	11.228	1.2152	0.9995	768	0.00096	0.000	1	T	0.000	1 .
1.00	142.86	3070	5815.0	11.228	1.2125	.9981	765	•00096		539.3	2.177	203	46
1.20	125.00 107.14	2998	5743.3 5662.6	11.228	1.2166	.9942 .9895	774 763	•00094	-552		1.264	.391	94
1.60	93.75	2848	5594.5	11.228	1.2109	9853	753	+00092 +00091	•755 •897	296.2	1.064		124
1.78	84.08	2793	5540.1	11.228	1.2199	.9819	745	•0009c	1.000	294.7	1.000		162
2 • 00 4 • 00	75.00 37.50	2736 2410	5484.2 5169.0	11.228	1.2209	.9782 .9550	736 683	•0008¢	1.100	295.8 318.6		1.021	176 241
10.00	15.00 14.70	2027	4809.9	11.228	1.2303	.9197	611	•00076	4.155	351.7	2.199		299
20.00	7.50	1770	4577.3	11.228	1.2300	.9189	252	•00070 •00062	2.167	352.4 372.8	2.228		331
40.00	3.75	טנכו	4374.7	11.228	1.2002	•8572	498	•00054	2.925	190.4	5.598	1.508	357
200.00	1.50 .75	1266	4147.8	11.228	1.2783	.0125	423	+00044	3.439	409.5	10.724	1.621	383
400.00	.38	925	3880.6	11.228	1.3000	•7804 •7516	316 368	•00037 •00031	3.846 4.280	420.8 430.3	17.650 29.113	1.688	399 413
1000.00	.15	742	3745.9	11.228	1.3257	•7204	253	•00024	4.907	440.4	56.470	1.803	427
000.00	-06 -04	624 523	3662.3 3592.1	11.228		.7028 .6586	212 176	•00020 •00016	5.433	446.5 451.5	93.204 153.804	1.838	
			R	= 0.700	• PERCE	NT FUEL	= 15.2		= 5.556	-	1	1	<u> </u>
1.00	150-00	3231	5138.3	12.482	1.2096	0.9187	825	0.00092	0.000		Ī	0.000	, O
1.05	142.66	3203	5113.3 5046.0	12.482	1.2099	.9175 .9143	822	•00092	.285	>22.5	2.174	.203	46
1.40	107.14	3047	4970.2	12.482	1.2108	•9143 •9105	811	•00089	• 756	331.5 295.4	1.263	•390 •526	120
1.60	93.75	4476	4406.2	12.482	1.2129	.9070	789	•00087	•877	487.2	1.010	.618	142
1.78	75.00	2921 2862	4000.1	12.482	1.2146	•9041 •9009	781 773	•00085	1.000	465.6	1.000	•682	156
4.00	37.50	2528	4505.4	12.482	1.2206	.8810	120	•000/8	1.102	286.9 309.3	1.009 1.299	.744 1.021	170 234
10.00	15.00	2136	4165.8	12.482	1.2303	.8504	648	•00068	2.156	341.8	2.213	1.266	290
20.00	14.70 7.50	2126	4158.8 3944.8	12.482		.8497 .8244	647 592	-00068	2.168	342.4	2,242		291
40.00	3.75	1634	3751.6	12.482	1.2500	.7960	535	•00-161 •00053	2.920	362.5 380.0	5.671	1.402	322
100.00	1.50	1354	3534.1	12.482	1.2070	.7556	459	•00044	3.427	398.7	10.922	1.625	373
400+00	75 و 8 و و	1167	3495.2	12.482	1.2813	.7251	4C2	•00037	3.628	410.2	18.053	1.694	389
000.00							348	•00031	4.251	419.7	29.905	1.751	402
000.00	•15 •08	606	3144.6 3062.6	12.482	1.3101	.6544 .6421	282	•00024 •00020	4.861 5.371	429.9 436.1	58.305 96.550	1.812	416
000.00	•04	573	2993,8	12.462	1.5381	•6300	198	•00016	5.930	441.2	159.767	1.879	432
			R	= 0.800	PERCE	NT FUEL :	13.6	0. 0/F	= 6.349				
1.00	150.00	3304	4586.9	13.622	1.2063	0+8531	851	88000+0	0.000		· · · · · I	0.000	. 0
1.05	142.86	3277	4563.5	13.622	1.2066	.8520	847	•00098	.285	500.8	2.172	. 203	45
1.40	125.00	3202	4500.4	13.622	1.2075	.8491 .8458	637 825	•00046 •00045	• 757	286.1	1.262	• 390 • 526	86 117
1.60	93.75	3047	4369.2	13.622	1.2093	.8428	815	+00004	• 700	218.2	1.010	-618	137
2.00	72.00	2992	4322.8	13.622	1.2101	.8403 .8374	507 798	د ۵۵۵۵۰	1.000	476.9	1.000	.681	151
4.00	31.50	2590	3992.8	13.622	1.2100	.8374	145	•00081 •00075	1.103	277.9 299.8	1.301	1.021	165 227
10.00	15.00	2178	3673.1	13.622	1.2206	.7925	: ف73	•00056	Z-156	331.5	4.442	1.266	262
10.21	14.70	2170	3000.5	10.622	1.2220	.7919	671	•0000>	2.160	332.1	2.251	1.271	283
20.00 40.00	7.50 3.75	1640	3464.5	13.622	1.2340	.7694	617 259	•00059 •00054	2.541	351.7 366.8	3.522	1.403	312 337
00.00	1.50	1405	3075.1	13.622	1.2001	.7068	483	•00043	3.421	387.3	11.042		
00.00	• 75	1214	2942.8	13.622	1.2739	.6/85	425	·0003/	3.817	298.6	18.300	1.628	362 378
	.38	1043	i	ļ	1.2800	-6>10	370	16000•	4.234	408.0	30.397	1.756	391.
00.00	•15 •08	710	2024.3	13.622	1.3214	•6175 8775	204	•00024	4.854	410.1	59.468	1.818	404
00.00	-04				1.3227	+5044	255 214	00020	5.334	424.2	98.706	1.855	413
			R	= 0.900.	PERCEN	T FULL =	12.28	 3≽ U/F	7.143	i		1	-
1.00	150.00	3336	4142.9	14.653	1.2044	0.7990	d70	0.00084		Т	Т	0.000	0
1.20	142.00	3214		14.653		.7954	066	•00084		490.1	2.1/1	.203	43.
	107.14	31>0	3942.0	14.653	1.2056	.7954	045	•00083 •00081		277.3	1.262	•389 •525	84. 113.
1.60	93.75	3078	3430.6	14.653	1.2074	.7896	832	•00000	•900	269.6	1.009	.618	133.
2.00	75.00	2962	3847.2	14.653	1.2001	. 7874 . 7848	824	•00078	1.000	268.3 269.4	1.000	•680	146
4.00	75.00 37.50	2625	3584.9		1.2143	.7684	761			290.6		1.021	160. 220.
10.00	12.00	2227	1284.0		1.2200	.7438	669		2.157	321.5	2.226	1.266	273.
20.00					1.2232	.7432	687	•000b3		322.1	4.456	1.271	274.
40.00	3.75				1.2408	.7227	032		2.741	341.Z	3.533	1.404	303. 326.
00.00	1.20	1641	2/19.7	14.00.	1				1		- !		
00.00					1.2002	.0000	440			3/2.9	11.109	1.030	351.
00.00					1.2044	.0125	202	•00000		396.2			279.
00.00	•15			14.023		.5822	315			406.1		1.821	393.
							468						
00.00	•05	620	2291.6	14.653	1 4 2 2 2	.5030 .5476	440	•00020 •00016		412.2	99.976		401.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(f) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature T,	Enthalpy,	Molecular weight,	Isentropic exponent,	heat,	Viscos- ity, μ,	Thermal conductivity,	Mach	Specific impulse in vacuum	Area	Thrust coefficient	Specifi
P _c /P	fb/sqin. obs	°K	col/p	900	γ	C _{p,}		k, cal/(secH ^O K)(cm		I vac.		C,	I, hiiseci/
				? = 1.00	D. PERC	ENT FUEL		19 0/F	l. = 7•93°	• • • • • • • • • • • • • • • • • • • •	1 .	.4	١
1.00	150.00	3341	3777.9	15.586	,	- 71		Τ	Г				,
1.05	142.86			10.586	1.2035	0.7539 .7530	882 878		0.000		2.170	0.000	
1.20	125.00	3239		12.206	1.2040	.7505	000	•000#0 •00079	•265 •254	4/5.5 30.6			42.
1.40	107-14	5155	3030.6	15.586		7417	052	•000/8	.758	469.1			110.
1.60	93.75	3084	3585.5	15.586		. 1452	845	•00076	.901	201.0			129.
1.78	84.45	3029	3544.7	15.586	1.2071	.7432	836		1.000	260.4		680	142
2.00	75.00		3499.4	15.586	1.20/9	.7407	627	•00074	1.104	261.4			155.
4.00	37.50	2631	3252.2	15.586	1.2132	•7254	772	•00068	1.607	282.1			213.
10.00	15.00	2234	2968.5	15.586	1.2217	•7025	699						
10.21	14.70	2226	2962.7		1.2217	.7019	697	•00060	2.157 2.168	312.1 312.7	2.228	1.266	265
20.00	7.50	1967	2785.1			.0028	042	•00054	2.540	331.3		1.271	
40.00	3.75	1724	2620.1	15.586	1.62342	.6006	284	•00048	2.915	341.5	3.752	1.010	
100.00		, , , , , ,											
100.00 200.00	1.50	1439	2435.8	15.586	1.2243	•6269	207	•00040	3.416	365.1			341.
400.00	.30	1074	2214.9	15.500	1.20/5	•6041 •5796	450 394	•00034	3.808	375.9	18.509	1.701	356.
	.,,,,	10,7	221747	13.700	1.5050	•3/96	394	•000₹9	4.221	384.9	30.621	1.760	368.
1000.00	•1>	675	2101.5	15.586	1.3013	•5201	324	•00043	4.612	374.0	60.495	1.822	381.
2000+00		741	2030.3	15.586	1.3120	.5322	276	•00019	5.303	400.5			390
4000+00	•04	626	1970.0	15.586	1.32/1	•5173	230	•000)16	5.841	405.4			396
			R	= 1.500	• PERCE	NT FUEL	= 7•7	49, 0/F	≖11•9∩5		<u> </u>		
1.00	150+00	3219	2626.1	19.176	1.2047	0.6098	965	0.00067	0.000			0.000	0+
1.05	142.86	3193	2609.9	19.176	1.2050	•6091	901	•00067	. 285	420.8	2.171	- 203	37
1.20	125.00	3121	2566.2	19.176	1.2058	•6071	890	•00066	.554	267.1	1.262	.389	72.
1.40	107.14	3040	2517.0	19.176	1.2068	•6047	876	-00064	•758	238.1	1.062	•526	97.
1.60	93.15 84.41	2971 2918	2475.4	19.176	1.2077	•6026	865	•00063	•900	231.5	1.010	.616	114.
2.00	75.00	2859	2408.0	19.176	1.2004	•6008 •5988	056 046	•00063 ¹	1.000	230.4	1.000	•680	
4.00	37.50	2532		19.176	1.2147	.5000	787	•00002	1.103	249.6	1.302		137.
			i			*****		200020		24740	1.502	1.021	1090
10.00	15.00	2148	1992.8	17.176	1.2235	+50/4	110	•00049	2.157	276.0	2.225	1.266	234.
10.21	14.70	2140	1988.2	19.176	1.2257	.5009	708	•00049	2.168	270.5	2.255	1.271	235.
20.00 40.00	7.50 3.75	1889	1847.9	19.176	1.2314	•5515	651	•00044	2.541	292.9	3.531	1.404	260.
40.00	3.13	1000	1720.8	19.176	1.2408	.5340	592	•00039	2.917	307.2	5.736	1.514	280.
100.00	1.50	1380	1577.0	19.176	1.2557	•5089	515	•00033	3.419	322.7	11.104	1.630	302.
200.00	. 75	1195	1484.7	19.176	1.2504	.4898	458	•00028	3.813	332.2	18.436	1.700	315.
400-00	•38	1029	1404.9	19.176	1.2823	•4708	403	•00024	4.227	340.2	30.698	1.758	326.
1000-00	•15	837	2224	10.174									
2000-00	•08	711	1316.6 1261.1	19.176	1.3141	•4482 •4336	287	•00019	4.819	348.7	60.267	1.821	337.
4000-00	•04	601	1214.1	19.176	1.3203	4212	244	•00016	5.311	353.9	166.710	1.859	344.
				1	·		1				_ 1000.10		
				= 2.000	PERCE	NT FUEL :		27, 0/F	15.873				
1.00	150.00	3045	2016+0	21-610	1.2087	0 • 5325	900	0+00058	0.000			0.000	0+
1.05	142.86		2002-4	21.610	1.2091	.5318	896	•00058		385.5	2.173	203	34.
1.20	125.00	2951	1965.8	21.610	1.2100	.5299	884	•00057	•>53	444.6	1.263	.390	66.
1.40	107.14	2873	1924.5	21.610	1.2111	•5275	870	•00056		218.0	1.053	-526	89.
1.60	93.75	2806	1889.6	21.610	1.2121	-5255	858	•00055		211.9	1.010	.618	104.
1.78	84.28	2755	1862.4		1.2129	•5238	848		1.000	210.9	1.000	•682	115.
4.00	75.00 37.50	2699	1833.2	21.610	1.2139	•5220 •5106	777	•00053	1.102	211.7	1.009	. 744	
	3,430	2302	101110	21.010	1.2770	• 5106	'''	•00049	1.605	228.3	1.299	1.021	173.
10.00	15.00	2017	1486.2	21.610	1.2289	.4937	697	•00042	2.156	252.3	2.215	1.266	214.
10.21	14.70	2009	1482.4	21.610	1.2271	.4933	695		2.168	252.8	2.244.	1.270	215.
20.00	7.50	1769	1365.7	21.610	1.2374	•4793	637	•00.138	2.542	267.6	3.500	1.402	237.
40.00	3.75	1546	1260+1	21.610	1.2470	.4645	577	•00033	2.921	280.6	5.685	1.512	256.
100.00	1.50	1284	1141.2	21.510	1.24	التحميا	h = :			i i		, ,	
200.00	•75	1109		21.610	1.2619	•4430 •4269	965	00028		494.5	10.972	1.626	275.
400.00	.38	952	999.5		1.2878	.4114	392			303.1	18.178 30.200	1.696	287.
	1		1				- / -	-00011			20.400		£ 7 1 •
	•15	772		21.610	1.3057	.3927	326	•00017	4.847	317.9	59.148	1.815	307.1
000+00		655			1.3167	-3605	28 L			322.5	98.262		314.
000.00	•08			21.610	1.3307	•3700	440			326.4		1.883	319.
000.00	•08 •04	552									L		
2000.00		552		= 3.000,	PERCEN	IT FUEL =	4 • 0		23.810				
1.00	150.00	2695	R 1381.4	24.614	1.2194	0.4468	859	0/F =	23.810	T	<u>_</u>	0.000	0.
1.00	150.00 142.80	2695	R 1381.4 1370.8	24.614	1.2194	0.4488	859 855	0.00047 0.00047	23.810 0.000 .283	337.8	2.180	-203	30 •
1.00 1.05 1.20	150.00 142.85 125.00	2695 2672 2606	R 1381.4 1370.8 1342.4	24.614 24.614 24.614	1.2194	0.4468 .4461	859 855 842	0.00047 .00047 .00046	23 • 810 0 • 000 • 283 • 251	415.5	1.266	.203 .391	30 • . 58 • .
1.00 1.05 1.20 1.40	150.00 142.80 125.00 107.14	2695 2672 2606 2536	R 1381.4 1370.8 1342.4 1310.4	24.614 24.614 24.614 24.614	1.2194 1.2190 1.2209 1.2221	0.4488 .4481 .4483	859 855 842 828	0.00047 .00047 .00046 .00045	23.810 0.000 .283 .251 .754	215.5	1.266 1.064	.203 .391 .527	30 • . 58 • . 78 • •
1.00 1.05 1.20 1.60	150.00 142.86 125.00 107.14 93.75	2695 2672 2608 2536 2415	R 1381.4 1370.8 1342.4 1310.4 1283.3	24.614 24.014 24.014 24.014 24.014	1.2194 1.2190 1.2209 1.2221 1.2233	0.4488 .4481 .4463 .4442	859 855 842 828 815	0.00047 .00047 .00046 .00045	23.810 0.000 .283 .251 .754 .896	415.5 191.9 186.5	1.266 1.064 1.010	.203 .391 .527	30 • . 58 • . 78 • .
1.00 1.05 1.20 1.40 1.79	150.00 142.8b 125.00 107.14 93.75 83.95	2695 2672 2606 2536 2415 2426	R 1381.4 1370.8 1342.4 1310.4 1283.3 1261.5	24.614 24.014 24.014 24.014 24.014 24.014	1.2194 1.2190 1.2209 1.2221 1.2233 1.2243	0.4488 .4481 .4463 .4442 .442	859 855 842 828 815 805	0.00047 .00047 .00046 .00045 .00044	23.810 0.000 .283 .251 .754 .896	215.5 191.9 186.5 185.6	1.266 1.064 1.010 1.000	.203 .391 .527 .620	30 · . 58 · . 78 · . 92 · . 102 ·
1.00 1.05 1.20 1.60	150.00 142.86 125.00 107.14 93.75	2695 2672 2608 2536 2415	R 1381.4 1370.8 1342.4 1310.4 1283.3 1261.5 1239.7	24.614 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2190 1.2209 1.2221 1.2233	0.4468 .4461 .4463 .4442 .4442 .4443 .4407	859 855 842 828 815	0+00047 +00047 +00046 +00046 +00044 +00044 +00043	23 • 810 0 • 000 • 283 • 251 • 754 • 896 1 • 000 1 • 098	215.5 191.9 186.5 185.6 186.2	1.266 1.064 1.010 1.000	.203 .391 .527 .620 .685	30. 58. 78. 92. 102.
1.00 1.05 1.20 1.40 1.60 1.79 2.00	150.00 142.80 125.00 107.14 93.75 83.95 75.00 37.50	2695 2672 2606 2536 2475 2426 2376 2089	R 1381.4 1370.8 1342.4 1310.4 1283.3 1261.5 1239.7 1114.9	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2190 1.2209 1.2221 1.2233 1.2243 1.2243 1.2253	0.4458 .4451 .4463 .4442 .4442 .4423 .4407 .4391	859 855 842 828 815 805 795	0+00047 +00047 +00046 +00046 +00044 +00044 +00043	23 • 810 0 • 000 • 283 • 251 • 754 • 896 1 • 000 1 • 098	215.5 191.9 186.5 185.6	1.266 1.064 1.010 1.000	.203 .391 .527 .620 .685	30. 58. 78. 92. 102.
1.00 1.05 1.20 1.40 1.60 1.79 2.00	150.00 142.80 125.00 107.14 93.75 93.95 75.00 37.50	2695 2672 2608 2536 2415 2426 2376 2089	R 1361.4 1370.8 1342.4 1310.4 1283.3 1261.5 1239.7 1114.9	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2209 1.2221 1.2223 1.2243 1.2243 1.2223 1.2243 1.2252	0.4488 .4481 .4463 .4442 .4423 .4407 .4391 .4285	859 855 842 828 815 805 795 731	0.00047 -00047 -00046 -00046 -00044 -00044 -00043 -00039	23-810 0-000 -283 -251 -754 -896 1-000 1-098 1-602 2-155	215.5 191.9 186.5 185.6 186.2 200.5	1.266 1.064 1.010 1.000 1.008 1.293	.203 .391 .527 .620 .685 .745 1.022	30. 58. 78. 92. 102. 111. 152.
1.00 1.05 1.20 1.40 1.79 2.00 4.00	150.00 142.80 125.00 107.14 93.75 75.00 37.50	2695 2672 2606 2536 2415 2426 2376 2089 1752 1745	R 1381.4 1370.8 1542.4 1283.3 1261.5 1289.7 1114.9 973.1 970.2	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2299 1.2209 1.2221 1.2233 1.2243 1.2253 1.2253 1.2253 1.2253 1.2322	0.4488 .4481 .4463 .4442 .4423 .4407 .4391 .4265	859 852 842 812 805 795 731 649 647	0.00047 .00047 .00045 .00045 .00044 .00044 .00043 .00039	23.810 0.000 .283 .351 .754 .896 1.000 1.098 1.602 2.155 2.167	215.5 191.9 186.5 185.6 186.2 200.5	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.219	.203 .391 .527 .620 .685 .745 1.022 i.265	30. 58. 78. 92. 102. 111. 152. 188. 189.
1.00 1.05 1.20 1.40 1.60 1.79 2.00 4.00	150.00 142.8b 125.00 107.14 93.75 63.95 75.00 37.50	2695 2672 2008 2336 2415 2426 2376 2089 1752 1745 1527	R 1361.4 1370.8 1342.4 1210.4 1283.3 1261.5 1239.7 1114.9 973.1 970.2 881.5	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2209 1.2221 1.2233 1.2243 1.2223 1.2222 1.2427 1.2427 1.2430 1.2518	0.4468 .4461 .4463 .4442 .4423 .4407 .4265 .4265 .4134 .4130 .4014	859 855 842 828 815 805 795 731 649 647	0.00047 .00047 .00046 .00045 .00044 .00044 .00043 .00039	23.810 0.000 .283 .551 .754 .896 1.000 1.098 1.602 2.155 2.167 2.245	215.5 191.9 186.5 185.6 186.2 200.5 221.1 221.6 234.3	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.219 3.451	.203 .391 .527 .620 .685 .745 1.022 1.265 1.269 1.399	30. 58. 78. 92. 102. 111. 152. 188. 208.
1.00 1.05 1.20 1.40 1.79 2.00 4.00	150.00 142.8b 125.00 107.14 93.75 63.95 75.00 37.50	2695 2672 2606 2536 2415 2426 2376 2089 1752 1745	R 1361.4 1370.8 1342.4 1210.4 1283.3 1261.5 1239.7 1114.9 973.1 970.2 881.5	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2299 1.2209 1.2221 1.2233 1.2243 1.2253 1.2253 1.2253 1.2253 1.2322	0.4488 .4481 .4463 .4442 .4423 .4407 .4391 .4265	859 852 842 812 805 795 731 649 647	0.00047 .00047 .00046 .00045 .00044 .00044 .00043 .00039	23.810 0.000 .283 .551 .754 .896 1.000 1.098 1.602 2.155 2.167 2.245	215.5 191.9 186.5 185.6 186.2 200.5	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.219 3.451	.203 .391 .527 .620 .685 .745 1.022 1.265 1.269 1.399	30. 58. 78. 92. 102. 111. 152. 188. 208.
1.00 1.05 1.20 1.40 1.60 1.79 2.00 4.00 10.21 20.00 40.00	150.00 142.80 125.00 107.14 93.75 63.95 75.00 37.50 15.00 14.70 7.50 3.75	2695 2672 2606 2936 2475 2426 2376 2089 1752 1745 1527 1326	R 1361.4 1370.8 1342.4 1310.4 1283.3 1261.5 1239.7 1114.9 973.1 970.2 881.5 601.7	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2209 1.2221 1.2233 1.2243 1.2223 1.2223 1.2232 1.2427 1.2430 1.2518 1.2621	0.4458 .4481 .4463 .4442 .4423 .4407 .4391 .4265 .4134 .4130 .4014 .3887	859 859 859 842 828 865 795 731 649 647 530	0.0047 0.0047 0.0047 0.0046 0.0044 0.0044 0.0044 0.0043 0.0033 0.0032 0.0032	23*810 0*000 -283 -251 -754 -896 1*000 1*098 1*602 2*155 2*167 2*245 2*920	215.5 191.9 186.5 185.6 186.2 200.5 221.1 221.6 234.3 240.3	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.219 5.451 5.565	.203 .391 .527 .620 .685 .745 1.022 1.265 1.269 1.399 1.507	30. 58. 78. 92. 102. 111. 152. 188. 189. 208.8
1.00 1.05 1.20 1.40 1.60 1.79 2.00 4.00	150.00 142.8b 125.00 107.14 93.75 63.95 75.00 37.50	2695 2672 2008 2336 2415 2426 2376 2089 1752 1745 1527	R 1361.4 1370.8 1342.4 1342.4 1310.4 1261.5 1239.7 1114.9 973.1 970.2 881.5 601.7	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2209 1.2221 1.2233 1.2233 1.2233 1.2233 1.2322 1.2427 1.2430 1.2518 1.2621	0.4458 .4481 .4463 .4442 .4423 .4407 .4391 .4205 .4134 .4130 .4014 .3087	859 855 842 828 815 805 795 731 649 647 530 457	0.00047 .00047 .00047 .00046 .00046 .00044 .00044 .00043 .00039 .00033 .00036 .00046	23*810 0*000 .283 .251 .754 .856 1.000 1.098 1.602 2.155 2.167 2.243 2.4730 3.448	215.5 191.9 186.5 185.6 186.2 200.5 221.1 221.6 234.3 249.3	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.219 5.451 5.765	.203 .391 .527 .620 .685 .745 1.022 1.265 1.269 1.399 1.507	30.: 58.: 78.: 92.: 102.: 111.: 152.: 188.: 208.: 244.:
1.00 1.00 1.00 1.20 1.20 1.40 1.60 1.79 2.00 4.00 10.21 20.00 4.00	150.00 142.80 125.00 107.14 93.75 63.95 75.00 37.50 15.00 14.70 7.50 5.75	2695 2672 2008 2036 2415 2426 2376 2089 1752 1745 1527 1326	R 1361-4 1370-8 1342-4 1310-4 1310-4 1283-3 1261-5 1239-7 1114-9 973-1 970-2 881-5 801-7 712-6	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2196 1.2209 1.2221 1.2233 1.2243 1.2223 1.2223 1.2232 1.2427 1.2430 1.2518 1.2621	0.4458 .4481 .4463 .4442 .4423 .4407 .4391 .4265 .4134 .4130 .4014 .3887	859 859 859 842 828 865 795 731 649 647 530	0.0047 0.0047 0.0047 0.0046 0.0045 0.0044 0.0043 0.0039 0.0033 0.0032 0.0026 0.0026	23-810 0-000 -283 -251 -754 -896 1-000 1-098 1-602 2-155 2-167 2-2-720 3-448 3-858	215.5 191.9 186.5 185.6 186.2 200.5 221.1 221.6 234.3 249.3 257.1 264.3	1.266 1.064 1.010 1.000 1.008 1.273 2.190 2.219 3.451 5.451 5.553	.203 .391 .527 .620 .685 .745 1.022 1.265 1.269 1.399 1.507	0 • (30 • 1 58 • 3 78 • 6 92 • 6 102 • 1 111 • 1 152 • 3 188 • 3 240 • 6 241 • 2 251 • 3
1.00 1.	150.00 144.86 125.00 127.14 93.75 75.00 37.50 14.70 7.50 37.50 15.00 14.70 7.50 37.50	26y5 2672 2008 2336 2415 2426 2376 2089 1752 1745 1527 1326 1091 936 799	R 1361-4 1570-8 1542-4 1510-4 1510-4 1529-7 1114-9 973-1 970-2 881-5 401-7 7112-6 555-9 507-4	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2190 1.2209 1.2209 1.2243 1.2243 1.2232 1.2242 1.2243 1.2322 1.2427 1.2430 1.2532 1.2532 1.2532	0.4458 .4451 .4453 .4442 .4423 .4423 .4407 .4391 .4265 .4134 .4130 .4014 .3867	859 859 842 828 815 805 795 731 647 589 530 457 405	0.0047 0.0047 0.0047 0.0045 0.0045 0.0044 0.0043 0.0033 0.0033 0.0032 0.0036	23-810 0-000 -283 -251 -754 -896 1-000 1-098 1-602 2-155 2-167 2-245 2-730 3-948 3-858 4-291	215.5 191.9 186.5 185.6 186.2 200.5 221.1 221.6 234.3 249.3	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.219 3.451 5.451 5.563	.203 .391 .527 .620 .685 .745 1.022 1.265 1.269 1.399 1.507	30.1 58.3 78.6 92.4 102.1 111.1 152.3 188.3 189.2 244.6 241.2 251.3
1.00 1.05 1.20 1.40 1.60 1.20 1.40 1.60 1.79 2.00 4.00 10.21 20.00 4.00 10.00 20.00 4.00 4.00	150.00 142.60 125.00 127.14 93.75 63.95 75.00 14.70 7.50 3.75 15.00 14.70 7.50 3.75	2695 2672 2006 236 2475 2475 2475 2089 1752 1752 1752 1326 1327 1327 1327 1327 1327 1327 1327 1327	R 1381-4 1370-8 1540-4 1510-4 120-3 1201-5 1239-7 1114-9 973-1 970-2 681-5 601-7 712-6 503-9	24.614 24.614	1.2194 1.2190 1.2209 1.2209 1.2245 1.2245 1.2245 1.2245 1.2250 1.2427 1.2450 1.2507 1.2077 1.2077	0.4468 44401 44402 44407 4420 44107 4420 44134 44130 44134 4300 4014 33007 43710 4374	859 842 828 815 805 795 731 647 589 530 457 405 356	0.0047 0.00047 0.00047 0.00045 0.00045 0.00044 0.00044 0.00043 0.00033 0.00033 0.00036 0.00046 0.00	23.810 0.000 .283 .251 .754 .896 1.000 1.098 1.602 2.155 2.167 2.245 2.256 3.438 3.438 4.291 4.914	215.5 191.9 186.5 185.6 186.2 200.5 221.1 221.6 234.3 240.3 257.1 264.5 270.5	1.266 1.064 1.010 1.000 1.000 1.293 2.219 3.451	.203 .391 .527 .620 .685 .745 1.022 1.269 1.399 1.507	30 - 1 58 - 3 78 - 6 92 - 4 102 - 1 111 - 1 152 - 3 189 - 2 208 - 6 241 - 2 259 - 5
1.00 1.	150.00 144.86 125.00 127.14 93.75 75.00 37.50 14.70 7.50 37.50 15.00 14.70 7.50 37.50	26y5 2672 2008 2336 2415 2426 2376 2089 1752 1745 1527 1326 1091 936 799	R 1361-4 1570-8 1542-4 1510-4 1510-4 1529-7 1114-9 973-1 970-2 881-5 401-7 7112-6 555-9 507-4	24.614 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014 24.014	1.2194 1.2190 1.2209 1.2209 1.2243 1.2243 1.2232 1.2242 1.2243 1.2322 1.2427 1.2430 1.2532 1.2532 1.2532	0.4468 .4461 .4463 .4442 .4423 .4407 .4391 .4205 .4134 .4130 .4014 .3007	859 842 842 815 805 731 647 731 647 732 9647 9647 9647 9647	0.0047 0.0047 0.0047 0.0045 0.0045 0.0044 0.0043 0.0033 0.0033 0.0032 0.0036	23-810 0-000 -283 -251 -754 -896 1-000 1-098 1-602 2-155 2-167 2-167 2-90 3-948 3-858 4-291 4-914 5-93	215.5 191.9 186.5 185.6 186.2 200.5 21.1 221.6 234.3 249.3 257.1 264.5 270.5 270.5	1.266 1.064 1.010 1.000 1.008 1.293 2.190 2.215 5.451 7.755 10.009 17.755 29.027 70.470 70.470 70.470	.203 .391 .527 .620 .685 .745 1.022 1.269 1.399 1.507	30.58.78.78.92.102.111.152.1152.1152.1259.1259.1259.1259.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASS. GNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OF YGEN

(f) Concluded. Combustion-chamber pressure, 150 pounds per square inch absolute; frozen composition during isentrop! expansion

Pressure rotio P_/P	Static pressure, P,	Temperature,	Entholpy, h,	Molecular weight,	Isentropic exponent,		Viscos- ity, µ, micra	Thermal conductivity, k, col/iseci ⁽¹⁾ Ki m	Mach number M	in vacuum, I _{vac}	ratio.	Thrust coefficient, C _f	Specific impulse,
С	ubs							cony isect. Kir m.		illbi⊹seci/lbi.			
		1		,				054, U.F				0.005	0•3
1.00	150.00 142.80		1054.4	26.287 . 26.287	1.2315	. 0.4022	191	0.000,0 0.000,0	.282	201.1	2.157	0.000	27.5
1.40	120.00	2283	1022.4	20.601	. 1.6232	1 3971	184	• 000. Y	• 248	195.0	1.259		92.6 71.2
1.40	107.14 75.75	2217		20.207	1.2346	.,4/6	770	•000. 8 •000. 7	.072	100.0	1.011	.621	03.0
1.79	ひょうり	2114	99249	20.201	1 1.23/3	• 5742	146	.00.)26	T • 000	100.5	1.000 800.1	•567 •141	100.5
2.00 4.00	/>•00 5/•50	20/1 1004	930.4 930.9	26.287 20.287	1.2304	• 5721 • 3021	130	•000≥6 •000≥4	1.094	180.0	1.250	1.075	13/00
10.00	15.00				1.25/6		25.1	•000-7			2.164	1.253	1/0.5
10.21 20.00		1302		10.287	1.20/9	.360f		•000/4	2.249	210.6	3.391	1.390	10/13
40.00		1123	282.5	10.701	1.2/05	. 5472		•000-1	2.940	420.3	5.435	1.501	
100.00 200.00	1.50	716	212.0	26.287	1.2919	• 1326 • 3470	404 260	•000-/ •000->	3.470	230.5 235.8	10.334 10.929	1.670	225 . 4
400.00 400.00	.30		433.0	20.201	1.0000		415	+000 3	4.007	241.7	27.812		
000.00			100.0	10.101	1.33/2	. (712	: 223		1 0.021	250.0	53.679 80.240	1.010	644.6
000.00	• 54		342.5	20.201	1.3094	• 2003 •		•000 /			144.929	1.045	246.4
				T				458. U.F					
1.00	150.00			27-307	1.2438	0.3/12	741	0.000 4	0.000	! ∡8∠•3	2.194	0.000	40.
1.05	142.86	1994	B28.1	21-301	1.2493	•3504	124	•000 ₺	.540	1/6.5	1.212	. 394	48.4 65.5
1.40	107.14		806.0	27.307	1.24/4	.3567		*000 °Z	. 586	159.1	1.050	.623 .623	
1.60 1.60	93.75 83.21		771.3	27.307	1.2000	. 3035	040	1.000	1.000	0.041	1.000	. 694	
2 • 0 0 4 • 0 0	15.00	1001	15/.6	- 27.301 - 27.301	1.2010	. 3521		. • 000 -1	1.004		1.007	1.073	
10.00			577.9	27.301	1.2122	. 1401			2+154	0.161			
20.00	14.10		21/05	1 21.301	1.2/27	1 -3204	400	•000 D	2.000	191.9	9.034		+/1+4
40.00	3.15		46>•6	27.001	1.2740	.3203				400•4			
100.00	1.50		177.48	1 /1-107	1.0291	.2172	, 318	-000	3.76	214.9	10.339	1.062	204 €
400.00			342.0	c1.301	1.00//	.2001			4.380			1.71/	
000.00	•1• •0•		290.2	127.001	1.504/	1 .2127	193	• 000 17	- 5.05 5.62	7 224.0 5 226.8	51•192 63•567 136•744	1.776	221.7
•000 • 00			212.0	27.001	1.0/03	. 2093	162	•000)10	6.240	5 229+1	136+744	1.020	224.
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TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(g) Combustion-chamber pressure, 300 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P.	Tempi erature, T,	Enthalpy.	Malecular weight,	Isentropic exponent,	Specific heat.	μ,	Thermal conductivity,	number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	Specific impulse I,
P _c /P	lb√sqim. abs	ĸ	cal/g) on	γ	c _{p.} col/(g⊤ K⊤	micro poises	cal/(sec)("K cm;	м	I _{voc.} ¹ ⊕ibiiseci/lb	ε	c,	idbilseci/
), PERCE	NY FOLL			= 1.190				
				1	, PERCE	NI FUEL			_ 1.13(т
1.00			5313.5	4.416	1.3396			0.00073	0.000			0.000	0.
1.05	285+71	1158	5287.7 5210.6	4.416	1.3406	1.7710	311 303		•271 •547	>30.0 334.2	2.250 1.297		47. 90.
1.40	214.29	1005	5141.8	4.416	1.3469	1.7472			.744	296.1	1.081		124.
1.60	187.50	1049	2077.7	4.416	1.3477	1.7269		•00066		285.6	1.018	. 636	143.
1.87	160.84	1008	>000.6	4.416	1.3528	1.7257		£3000	1.000	284.1		. 725	163.
2 • 00 ·	150.00 75.00	989	4975.4	4.416	1.3540 1.3631	1.6025		+00062	1.059	284.4 301.7	1.003	1.01	171.
7.00	12400	32.4	407744		1.,,,,,	1.0017							
10.00	⊅0 • U C	040	4372.5	4.410	1.5/48	1.6200	100	•00042	2.152	321.5	1.974		253.
20.00	15.00	532	4209.8	4.410	1.3799	1.6344	159 156	خد000 ·	2.586 2.599	245.5 945.9		1.376	309.
40.41	14.70 7.20	439	4004.9	4.416	1.3824	1.6268	130	•00049	3.031			1.467	330.
.000													
100.00	4.00		3899.0		1.3002	1.6073		•00023	3.648	369.8	6.432	1.558	350
400.00	1.50	530	3802.6 3723.2	4.416	1.3926	1.5761		*00019	4.149	377.7	13.431	1.652	362
400.00	• 13	230	3163.2	4.416	1.4000	1.5502	70	•00015	4.015	30411	22.4400	1.032	
1000.00	•30	175	3640.1	4.416	1.4349	1.4847	55	+00011	5.438		39.928		381
2000.00			3590.9		1.4550	1.4389	45	•00009		394.3		1.719	387
•000•00	• 0 8	114	3551.2	4.416	1.4705	1.4065	36	•00007	6.845	397.3	100.938	1.739	391
-			F		. PERCE	NT FUEL	= 38•8	5. O/F	= 1.587				
				1		l .		-					
1.00	300.00	1514 1497	2969.7	20216	1.3079	1.6183	402 399	0.00084	0.000	>><•2	2.233	0.000	49
1.05	250.00	1450	2941.7	2.216	1.3140	1.6140	399	•000001	.213	348.6	1.209	• 400	94.
1.40	214.27	1370	2703.2	5.216	1.0105	1.5007		•00078	•730	309.3	1.077	.539	127
1.60	187.50	1354	2713.2	5.216	1.3185	1.5772		•00076		299.6	1.016	•632	149
1.85	162.47	1354	2640.5	5.216	1.3217	1.5554			1.000	291.5 291.8	1.000		169
2 • 00 4 • 00	75.00	1282	2601.1		1.3235	1.5046		.00061		316./		1.029	243
	.,,						1						
10.00	30.00		1954.3		i・シラフB	1.4516		•00048		544.7		1.257	325
20.00	15.00	709	1748.8	5.216	0006.1	1.4232		•00040 •00040	2.273	362.0 362.4		1.379	325
20.41 40.00	14.70 7.50	508	1578.0		1.3030	1.4000		•00040		376.0		1.472	340
40.00	, • , 0	1	13.040	,,,,,		11.000		13002		•			
100.00	00 • د	458	1396.3	2.210	1.01/1	1.3713		•00026	3.619	190.0		1.565	
200.00	1.50	314	1286.2		10001	1.300/		*00075	4.111	399∗i 400∗i		1.662	
400.00	• 7>	312	1192.2	2.210	1.3001	1.3077	70	.00016	4.656	-00 1	22.270	1.002	3,2,
1000.00	• 10	242	1099.0	5.216	1.39/3	1-3400	14	•00013	5 - 394	410.4	41.979	1.706	403
2000.00	• 15	198	1041.i		1.4125	1.52411	61	•00011		411.1			109.
+000•00	•06	161	993.9	2.510	1.4320	1.2068	>0	•00009	5.704	421+1	108.754	. 1.754	4144
			Ä	- ! = 0•250	, PERCE	NT FUEL	= 33.5	1. 0/F	= 1.984				
:		٠		1									r _
1.00		1817	1249.3	6.016	1.2835	1.4955	481 477	0.00092 .00091	0.000	563.4	2.219	0.000 .207	50
1.05	285.71 250.00		1142.1			1.4013	467	•00089	• > 3 B	356.4		398	96.
1.40	214.29	1685	1054.8	6.016	1.2900	1,4093	456	•00055	.736	516.5	1.0/3	•536	110.
1.60	107.50	1635	981 . 5	0.010	1.2721	1.4091	440	•000093	.876	306.6	i.01>	.629	152
1.03	163.90	1500	909.9	0.010	1.2794	1.4440	425 427	100000		304.5 305.1	1.000	.708 .754	1/1-
2 • 00 4 • 00	150.00 75.00	1554	864.0 232.2	6.016	1.2973	1.00/5		•00000	1.079	345.5	1.4256	1.027	249
4.00	12000		,,,,,,,	0.010		,		-000		-		•	
10.00	30.00	1057	176.3	6.016	1.0329	1.3223		•000>4	2.147	155.1	2.048	1.258	305
∠0.00	1>.00	887	9954.5	6.016	1.3401	1.2846		•00046			3.127		، خارد ، خادد
20.41	14.70	740	9948.3 9/68.5	0.010	1.3404	1.2030	261	•0004> •00038		374.1 388.6	3.167 4.883	1.386	359
40.00	1.00	,40	310047	0.010	1.5707	1		•00000	22701				
100.00	00 • د	580	9569.5	0.010	1.3063	1.2520	101	•000000	3.281	404.1	8.985	1.575	302.
200.00		48 į	9448.3	0.0.0	1.3/1/	1.2191	151	•00325	4.064 4.062	413.1 420.9	14.375 23.207	1.630	395 406 •
	• 75	344	9347.8	5.010	1.3/22	1.5100	124	• 300 £ 0	4.282	74U+7	23.407		705
400•00	• 13									420.1	43.070		418
400.00		310	4741.1	6.016	1.3561	1 - 1 7 4 5	49	•00012	2 + 3 2 1				424.
400.00 0	• 5 0	310 256	9241.1 9170.5	0.010	1.3861	1.000	10	-00017	2.742	41141	11.214	1.749	
400.00 0	• 5 0			0.010	1.3000	1 • 1 4 9 5 1 • 1 9 0 5 1 • 1 3 4 9	70	-00017	2.742	41141	11.2/4	1.771	430.
400.00	• 5 0	256	9170.5	0.010	1.3005	1.1402 1.1402	/a 54	•00014 •00014	5.943 5.506	437.1 :	11.214 115.639	1.771	430.
400.00 .000.00 .000.00	• 50 • 15 • 08	210 210	9176.9 9123.3	0.010 0.010 = 0.300	1.3005 1.4019	1.1402 1.1402 HT FUEL	78 54 = 29•	*00012 *30310	5.745 5.606 = 2.381	437.1 ·	/1.2/4 115.639	. 1.771	430.
400.00 .000.00 .000.00	• 50 • 15 • 08	210 210	9170.9 9123.3 8	0.010 0.010 = 0.300	1.3005 1.4039 . PERCE	1.1805 1.1462 HT FUEL 1.3933	29•5	•09012 •30310 67, U/F	5.745 5.606 = 2.381	437.1 ·	115.634	0.000	430.
400.00 .000.00 .000.00 .000.00	.30 .12 .08	2093 2012	9170.9 9123.3 8	0.010 0.010 = 0.300	1.3nd) 1.4017 • PEKCE 1.2647 1.2000	1.1000 1.1402 HT FUEL 1.3933 1.3903	29•5 550 547	00012 •30310 67, U/F 0•00097 •00096	0.000 27d	437.1 ·	2.208 1.278	0.000 .206	0.
400.00 000.00 000.00 000.00 1.00 1.00	• 50 • 15 • 08	2093 2002 2012 2015 1950	9170.5 9123.3 8 9932.7 9903.1 9823.3	0.010 0.010 0.010 = 0.300 6.814 6.814	1.3nd0 1.4017 PEKCE 1.2647 1.2020 1.2070	1.1000 1.1402 HT FUEL 1.3930 1.3903 1.3910	29*5 550 547 536	00012 +00010 07+ 0/F 0+00097 +00094 +00091	0.000 278 0.500	933.3 937.1 37.1 359.7 359.7	2.208 1.278 1.071	0.000 .206 .396	0. 50. 97.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 203.71 200.00 244.24	2093 2010 2093 2012 2015 1950	9170.5 9123.3 8 9932.7 9932.1 9823.5 9134.4 9559.6	0.010 0.010 = 0.300 6.814 6.814 6.814	1.3000 1.4037 PERCE 1.2647 1.2000 1.2000 1.2701	1.3935 1.3935 1.3816 1.3715	29.5 550 547 536 547	00012 +30310 67, U/F -00097 +00094 +00091 +00049	0.949 6.606 = 2.381 0.000 .276 .542 .741	933-3 437-1 1 2000-0 309-7 319-7 310-1	2.208 1.278 1.071 1.013	0.000 .206 .396 .533	0. 50. 97. 131.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 202.71 200.00 214.27 16.50	2093 2072 2073 2072 2075 1990 1894	9176.5 9123.3 N 9932.7 9903.1 9823.5 9134.4 9590.0	0.010 0.010 = 0.300 6.814 6.814 6.814	1.3000 1.4037 PERCE 1.2647 1.2000 1.2000 1.2701	1.3935 1.3935 1.3816 1.3715	29.5 550 547 536 547	0.00012 0.00010 0.00097 0.00096 0.0094 0.0091 0.00097	0.000 276 542 741 881	955-3 937-1 950-5 959-7 919-7 910-1	2.208 1.278 1.071 1.013	0.000 .206 .396 .533 .626 .701	0. 50. 97. 141. 154. 172.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 300.00 203.71 2>0.00 21*42 167.50 162.04	2093 2072 2072 2073 2074 2015 1950 1844 1806	9170.5 9123.3 8 9932.7 9932.1 9823.5 9134.4 9559.6	0.010 0.010 0.010 0.010 0.014 0.014 0.014 0.014	1.3nd0 1.4017 PEKCE 1.2647 1.2020 1.2070	1.7000 1.1402 HT FUEL 1.3935 1.3905 1.3016 1.3715 1.3621 1.3022 1.3465	29.5 550 547 536 547 536 547 537 497	0.00012 0.00010 0.00097 0.00097 0.00094 0.00091 0.00089 0.00087	0.949 6.506 = 2.381 0.000 .278 .542 .741 .881 1.000 1.082	933-3 437-1 1 2000-0 309-7 319-7 310-1	2.208 1.278 1.071 1.013 1.000	0.000 .206 .396 .533 .626 .701	0. 50. 97. 131. 154. 172.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 202.71 200.00 214.29 10.50 150.04 150.00 72.00	2093 2072 2015 1950 1895 1844 1806 1550	9176.5 9123.3 N 9932.7 9903.1 9823.5 9734.4 9590.0 9539.2 9200.5	0.010 0.010 0.010 0.300 0.814 0.814 0.814 0.814 0.814 0.014	1.30d) 1.4017 . PERCE 1.2647 1.2605 1.2701 1.2701 1.2724 1.2724 1.2705	1.1809 1.1402 NT FUEL 1.3939 1.3905 1.3816 1.3715 1.3621 1.3732 1.3905 1.2976	29*1 550 547 536 525 514 505 497	0.00012 0.00010 0.00097 0.00096 0.00094 0.00091 0.00089 0.00087 0.0089 0.00074	0.949 6.606 = 2.381 0.000 .27d .542 .741 .881 4.000 1.082 1.569	955.3 937.1 956.5 959.7 919.7 910.1 908.2 908.9 930.3	2.208 1.278 1.278 1.071 1.012 1.000 1.000	0.000 .206 .396 .533 .626 .701 .751	0. 50. 97. 141. 154. 172. 189. 252.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 200.71 200.00 24.27 200.00 24.27 10(-50) 105.04 150.00	2093 2072 2015 1950 1894 1806 1550	9170.5 9123.3 8932.7 9903.1 9823.5 9734.4 9599.6 9599.6 9599.6 9599.6	0.010 0.010 2 0.300 6.814 6.814 6.814 6.814 6.814 6.814 6.814	1.360) 1.4017 . PERCE 1.2647 1.2605 1.2701 1.2724 1.2747 1.2747 1.2745	1.3933 1.3933 1.3933 1.3903 1.3621 1.3621 1.3621 1.3732 1.3465 1.2976	29.6 550 547 530 525 514 502 497 444	0.00012 -00010 57. U/F 0.00097 -00094 -00091 -00089 -00087 -00089	0.949 5.506 = 2.381 0.000 .27d .542 .741 .888 1.000 1.082 1.569	955.3 437.1 956.5 959.7 919.7 910.1 908.2 908.9 9390.3	2.208 1.278 1.278 1.071 1.012 1.000 1.000	0.000 .206 .396 .533 .626 .701 .751	0. 50. 97. 141. 154. 172. 189. 252.
1.00 1.00 1.00 1.00 1.00 1.20 1.40 1.60 1.60 1.60 1.60 2.60 2.60	300.00 202.71 200.00 214.27 107.00 102.04 103.00 703.00	2093 2072 2073 2072 2015 1950 1844 1896 1550	9932-7 9932-7 9903-1 9823-9 9734-4 9099-6 9990-9 9339-2 9200-9	0.010 0.010 0.010 0.010 0.014 0.014 0.014 0.014	1.3889 1.4037 • PERCE 1.2647 1.2609 1.2704 1.2724 1.2724 1.2724 1.2769	1.3933 1.3933 1.3903 1.3905 1.3621 1.3621 1.3621 1.3621 1.3925 1.2946 1.2946	29*1 550 547 536 525 514 514 514 497 444	0.00012 -00010 -00097 -00094 -00094 -00091 -00089 -00087 -00089 -00080	0.949 5.506 = 2.381 0.000 .27d .542 .741 .888 1.000 1.082 1.569	955.3 437.1 956.5 959.7 919.7 910.1 908.2 908.9 9390.3	2.208 1.278 1.071 1.012 1.000 1.260	0.000 206 396 533 626 701 1.025	0. 50. 97. 131. 154. 172. 185. 252.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 202.71 200.00 24.27 16.50 16.50 75.00 30.00 75.00	2093 2093 2072 2012 2015 1950 1895 1844 1590 1052	9176.5 9123.3 8932.7 9932.7 9823.5 9134.4 9590.0 9539.2 9200.5 8826.7 8593.0	0.010 0.010 2.0.300 6.814 6.814 6.814 6.814 6.614 6.614 6.614 6.614	1.3600 1.4017 . PERCE 1.2647 1.2600 1.2704 1.2704 1.2700 1.2700 1.2700 1.2700 1.2700 1.2700 1.2700	1.000 1.1402 HT FUEL 1.3933 1.3903 1.3010 2.3713 1.3021 1.3722 1.3405 1.2970	29*1 50 547 536 525 514 50 547 536 525 514 50 57 547 547	0.00012 -00010 57.	0.549 0.600 278 0.600 278 0.418 0.821 1.000 1.082 1.082 1.082 2.146 2.255 2.256	955.3 937.1 956.5 959.7 919.7 910.1 908.2 908.9 930.3	2.208 1.278 1.071 1.013 1.000 1.200 1.260 2.084 3.205 3.247	0.000 .206 .396 .533 .626 .701 .751	97. 131. 154. 172. 182. 252.
1.00 1.00 1.00 1.00 1.00 1.20 1.40 1.60 1.60 1.60 1.60 2.60 2.60	300.00 202.71 200.00 202.71 270.00 214.27 107.50 150.00 72.00 30.00 11.70 7.50	2093 2093 2072 2012 2015 1950 1895 1844 1590 1052	9932-7 9932-7 9903-1 9823-9 9734-4 9099-6 9990-9 9339-2 9200-9	0.010 0.010 2.0.300 6.814 6.814 6.814 6.814 6.014 6.014 6.014 6.014 6.014	1.3000 1.4037 . PERCE 1.2047 1.2050 1.2701 1.2724 1.2760 1	1.3933 1.3933 1.3903 1.3905 1.3621 1.3621 1.3621 1.3621 1.3925 1.2946 1.2946	29*1 50 547 536 525 514 50 547 536 525 514 50 57 547 547	0.00012 -00010 07.	0.949 6.606 = Z.381 0.600 274 .542 .741 .881 1.000 1.082 1.082 1.090 2.146 2.000 2.769	950.3 437.1 37.1 357.7 357.7 310.1 308.2 308.9 350.3	2.208 1.278 1.071 1.012 1.000 1.000 1.266 2.084 3.203 3.247 5.035	0.000 .206 .396 .513 .626 .701 1.751 1.025	97. 131. 154. 172. 182. 252. 310. 342. 365.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 200.71 200.00 200.71 200.00 210.27 101.20 100.04 100.04 100.00 11.70 10	2093 2092 2012 2012 1999 1844 1896 1200 1002 1002 1002 1002 1002	9170.5 9123.3 8 9432.7 9403.1 9623.5 9134.4 9594.6 9594.6 9594.6 9594.6 9594.6 9594.6 9594.6 9594.6	0.010 0.010 0.010 6.814 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014	1.3000 1.4017 . PEKCE 1.2047 1.2056 1.2066 1.2104 1.2724 1.2760 1.2760 1.2760 1.2761 1	1.1009 1.1402 NT FUEL 1.3933 1.3903 1.3610 2.3713 1.3621 1.3905 1.2976 1.1007 1.1007 1.1007	29 • 1	00012 90010 77, U/F 0.00097 -00094 -00094 -00097 -00089 -00007 -00089 -00090 -00090 -00090 -00090 -00090 -00090	0.000 .27d .542 .741 .881 .000 1.082 1.082 2.146 2.576 2.769	9564.5 9574.7 9584.5 9594.7 968.9 968.9 969.5 961.5 960.4 996.7 412.1	2.208 1.278 1.071 1.012 1.000 1.260 2.084 3.205 3.247 5.035	0.000 .206 .396 .533 .626 .701 .751 1.025 1.260 1.387 1.390	0. 50. 97. 141. 154. 185. 252. 365. 390.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 202.71 270.00 24.27 10/20 10/	2093 2093 2012 2015 1950 1844 1806 1550 1052 1052 1052 1055	9932-7 7123-3 8 9932-7 7903-1 7952-5 7134-4 7579-6 7579-6 7579-6 7579-6 7579-6 7579-6	0.010 0.010 0.010 0.010 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014	1.3nd2 1.4037 . PERCE 1.2047 1.2050 1.2070 1.2704 1.2747 1.2769 1.2070 1.2070 1.2070 1.2070 1.2070 1.2070 1.2070 1.2070	1.1009 1.1402 1.3933 1.3903 1.3903 1.3621 1.3032 1.3405 1.2476 1.1067 1.1067 1.1172	76 54 540 547 550 547 536 525 514 547 444 375 523 276 223	.00012 .00010 .0007 .0009 .0000 .000	0.000 0.000 27d 542 741 881 1.000 1.082 1.082 2.146 2.007 2.146 2.007 4.047	935.3 437.1 508.2 509.7 319.7 319.7 319.2 308.2 308.9 350.5 350.5 350.5 350.5 413.1	2.208 1.278 1.071 1.013 1.000 1.000 1.200 2.084 3.203 3.247 5.033 7.320	0.000 .206 .396 .533 .626 .701 .751 1.625 1.387 1.380 1.460	000 500 970 1310 172 1820 2520 3410 3420 3650
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 202.71 270.00 24.27 10/20 10/	2093 2093 2012 2015 1950 1844 1806 1550 1052 1052 1052 1055	9170.5 9123.3 8 9432.7 9403.1 9623.5 9134.4 9594.6 9594.6 9594.6 9594.6 9594.6 9594.6 9594.6 9594.6	0.010 0.010 0.010 0.010 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014	1.3000 1.4017 . PEKCE 1.2047 1.2056 1.2066 1.2104 1.2724 1.2760 1.2760 1.2760 1.2761 1	1.1009 1.1402 1.3933 1.3903 1.3903 1.3621 1.3032 1.3405 1.2476 1.1067 1.1067 1.1172	76 54 540 547 550 547 536 525 514 547 444 375 523 276 223	00012 90010 77, U/F 0.00097 -00094 -00094 -00097 -00089 -00007 -00089 -00090 -00090 -00090 -00090 -00090 -00090	0.000 0.000 27d 542 741 881 1.000 1.082 1.082 2.146 2.007 2.146 2.007 4.042	935.3 437.1 508.2 509.7 319.7 319.7 319.2 308.2 308.9 350.5 350.5 350.5 350.5 413.1	2.208 1.278 1.071 1.013 1.000 1.000 1.200 2.084 3.203 3.247 5.033 7.320	0.000 .206 .396 .533 .626 .701 .751 1.025 1.260 1.387 1.390	000 500 97. 131. 154. 172. 182. 252. 310. 341. 342. 365.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 203.71 200.00 243.71 200.00 243.27 107.50 103.00 703.00 12.00 12.00 13.00 13.00 1.70 7.50	2093 2012 2013 2014 2015 1990 1895 1896 1590 1052 1052 1052 1053 469	9170.3 9123.3 9432.7 9403.1 9623.3 9790.0 9790.0 9790.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0	0.010 0.010 0.010 0.010 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014	1.3nd) 1.4017 PERCE 1.2047 1.2030 1.2070	1.1602 1.1402 HT FUEL 1.3932 1.3903 1.3621 1.3621 1.3623 1.4605 1.4940 1.1007 1.1074 1.1005 1.1005 1.0060 1.0060	29*: 550 547 530 525 514 502 497 444 372 323 273 1800 120	.0001z .00010 .00097 .00094 .00091 .00091 .00091 .00090 .00000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	5.745 5.606 = Z.381 0.600 27d 544 2741 881 1.600 1.082 1.082 1.082 2.146 2.255 2.257 2.267 4.214 5.240	954.5 937.1 954.7 959.7 959.7 959.3 961.5 960.9 950.9 961.7 410.1 424.9 950.7	2.208 1.278 1.071 1.012 1.000 1.000 1.200 2.084 3.427 5.035 7.247 9.350 14.504 24.219	0.000 .206 .396 .533 .626 .701 .751 1.625 1.387 1.387 1.346 1.485	97. 131. 154. 172. 1852. 252. 310. 341. 342. 365.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300.00 203.71 200.00 243.71 200.00 243.27 107.50 103.00 703.00 12.00 12.00 13.00 13.00 1.70 7.50	2093 2012 2013 2014 2015 1990 1895 1896 1590 1052 1052 1052 1053 469	9170.3 9123.3 9432.7 9403.1 9623.3 9790.0 9790.0 9790.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0 97970.0	0.010 0.010 0.010 0.010 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014	1.3nd2 1.4037 . PERCE 1.2047 1.2050 1.2070 1.2704 1.2747 1.2769 1.2070 1.2070 1.2070 1.2070 1.2070 1.2070 1.2070 1.2070	1.1602 1.1402 HT FUEL 1.3932 1.3903 1.3621 1.3621 1.3623 1.4605 1.4940 1.1007 1.1074 1.1005 1.1005 1.0060 1.0060	29*: 550 547 530 525 514 502 497 444 372 323 273 1800 120	.0001Z .0001Z .0001Z .00094 .00094 .00094 .00097 .0009Z .0009Z .0009Z .0009Z .0002Z .0002Z .0002Z .0002Z	2.381 0.000 2/76 5/42 1.881 1.000 1.082 1.583 2.146 2.257 2.267 2.767 4.014 4.516	935.3 937.1 359.7 359.7 319.7 310.1 308.2 308.9 350.9 350.9 413.1 422.9 435.9	2.208 1.278 1.071 1.013 1.000 1.000 1.200 2.084 3.203 3.247 5.033 7.320	0.000 .096 .096 .096 .013 .021 .701 1.022 1.260 1.387 1.390 1.469 1.589 1.736	97. 131. 154. 172. 182. 252. 310. 341. 342. 342. 340. 442. 445.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID DXYGEN

(g) Continued. Combustion-chamber pressure, 300 points per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, μ,	Thermal conductivity,	((O))(OB)	Specific impulse in vacuum,	Area ratio,	Thrust coefficient,	Specifi impulsi
P _c /P	No∕sq⊪n. obs	°K	cal/g	900	γ	C _{P.} col/(g)(°K)	micro poises	k cal/(sec) *K)(cm)		I roc, (lb)(sec)/lb	ε	Ct	I, No)(sect/
<u> </u>					0000	L	Li		L		J		
-				0.350) PERCE	NT FUEL	= 26+	47, 0/1	= 2.77		,		
1.00	300.00	2344	8892.8	7+607	1.2502	1.3052	610	0.00100	0.000	- (() E		0.000	٠٥٠
1.05	285.71 250.00	2321 2259	8663.0 8783.2	7.607	1.2509	1.3025	607 597	•00099 •00097	-280 -245	269.5 360.6	2.199	• 205 • 394	50 • 97 •
1.40	214.29	2190	8693.6	7.607	1.2548	1.2864	585	•0(094	.745	340.7	1.069	.532	131.
1.60	187.50	2131	8618.2	7.607	1.2567	1.2769	>75	+00092	.886	311.3	1.012	.624	154.
1.81	165.96	2079	8551.1	7.607	1.2564	1.2720	565	*00090	1.000	309.4	1.000	•696	172.
2.00 4.00	150 • 00 75 • 00	2036 1760	8496.8 8153.6	7.607 7.607	1.2600	1.2229	557 503	*00089	1.087	310.3 332.5	1.007	.749 1.024	185. 253.
4.00	75.00	1760	0153.6	1.007	1.2.11	1,,,,,	700	*01016	1.270	236.5	1.214	4.027	2,50
10.00	30.00	1440	7771.6	7.607	1.2896	1.1634	434	+00064	2.150	364.7	2.116	1.261	312.
20.00	15.00	1229	7530.3	7.607	1.3046	1.1168	378	•06055	2.051	384.9 385.4	3.275 3.319	1.390	344
40.00	14.70 7.50	1223	7523.7 7325.1	7.607 7.607	1.3051	1.0779	377 327	+00054 +00046	2.954	401.4	5.178	1.394	345. 369.
10000			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					1000					
100.00	00 و د	831	7101.8		1+3374	1.0356	265	•0C 336	3.514	418.7	9.654	1.594	394
200.00	1.50 .75	696 581	6963.9 6848.6	7.607	1.3482	1.0114	223 187	•00030	3.968 4.457	429.0 437.4	15.587 25.250	1.654	409
400.00	•13	201	0040.0	1.007	1.3300	.,,,,,	101	•06025	41477	437.44	23.200	10,700	721
1000.00	•30	456	6725.1	7.607	1.3639	.9790	146	•00019	5.168	446.2	48.144	1.754	434.
2000.00	-15	378	6649.8	7.607	1.3690	•9693	119	•00015	5.758	451.5	78.603	1.784	441
+000-00	•08	314	6587.3	7.607	1.3740	.9598	97	•00012	6.400	455.8	128.518	1.808	447
			R	= 0.400	, PERCE	NT FUEL	= 23.9	95. J/F	= 3-179	,			
1.00	300.00	2565	8050.5	8.389	1.2389			0.00101	0.000			0.000	0
1.05	285.71	2541	8021.0	8.389	1.2394	1.2265	658	•00100	.281	267.5	2.192	•205	50
1.20	250+00 214+29	2476 2403	7941.7 7852.6	8.389	1.2409	1.2128	646 636	•00098 •00096	• 247 • 748	359.5	1.271	.393 .530	97.
1.40	187.50	2403 2341	7777.6	8.389	1.2444	1.2062	626	•0C 396	.889	310.6	1.012	,622	154
1.00	160.67	2287	7713.0	8.389	1.2459	1.2003	617	• 0C 392	1.000	308.9	1.000	•692	171
2.00	150.00	2240	7656.5	8.389	1.2473	1.1949	609	•00091	1.091	309.8	1.007	• 748	185
4.00	75.00	1948	7313.1	8.389	1.2571	1.1582	555	•00 381	1.594	332.6	1.281	1.023	253
10.00	30.00	1608	6928.0	8.389	1.2730	1.1047	482	•00 368	2.152	365.6	2.142	1.262	312
20∙00	15.00	1382	6682.9	8.389	1.2870	1.0623	427	•0€358	2.548	386.3	3,335	1.393	345
20.41	14.70	1376	6676.2	8.389	1.2874	1.0611	426 373	•0C 358	2.560	386.8	3.380	1.397	345
40.00	7.50	1180	6472.9	8.389	1.3020	1.0213	213	•00049	2.944	403.3	5.305	1.496	370
100.00	00 و د	949	6242.4	8.389	1.3215	.9738	106	+06 339	3.488	421.3	9.963	1.602	396
200.00	1.50	800	6099.1	8.389	1.3343	.9455	260	+00332	3.929	432.1	16.162		412
400.00	• 75	671	5978.6	8.389	1.3448	.9239	219	•00 327	4.403	440.9	26.311	1.715	424.
000.00	٥٤.	529	5849.0	8.389	1.3226	.9031	171	.00321	5.091	450.1	50.311	1.768	437
000.00	.15	441	5769.6	8.389	1.3012	.8725	142	•00017	5.667	455.7	82.327	1.799	445.
000.00	• 05	366	5703.5	8.389	1.3005	.8833	110	•00014	6.293	460.3	134.918	1.825	451
			R	= 0.450	. PERCE	NT FUEL	= 21.8	37,)/F	= 3.571				
	300+00	2755	7354.5	9.152	1.2300	1.1611	705	0.00101	0.000		· · · · · · · · · · · · · · · · · · ·	0.000	0
1.00 1.05	285.71	2730		9.152	1.2305	1.1591		•00:00	-282	563.2	2.186	-204	50
1.20	250.00	2662	7247.2	9.152	1.2318	1.1537	691	•0C)98	.549	357.0	1.268	.392	96
1.40	214.29	2586	7159.4	9.152	1.2334	1.1475	679	•0C 396	•751		1.066	.529	130
1.60	187.50	2521 2467	7085.4 7023.4	9.152 9.152	1.2348	1.1420	669 661	•00)95 •00)93	.892 1.000	308.7 307.0	1.011	.621 .689	153
2.00	167.23	2416	6965.8	9.152	1.23/2	1.1312		• OC 192	1.094	304.0	1.008	.747	183
4.00	75.00	2112	6625.4	9.152	1.2459	1.1000	599	•00)82	1.598	331.1	1.286	1.022	251
ĺ					;			_					
10.00	30.00	1755	6241.6		1.2600	1.0138	526 471	•0C)70	2.153	364.5	2,163 3,384	1.263	311.
20.00	15.00 - 14.70	1517	2992.6 2988.9		1.2726	1.0126	469	•00)60 •00)60	2.558	386.1	3.431	1.399	344.
40.00	7.50	1304	5783.6	9.152	1.2868	.9743	415	•0C)52	2.936	403.0	5.411	1.501	369
													201
	3+00	1057	3549.4		1.3067	.9251	344 295	-00)41	3.469	421.5 432.7	10.232	1.673	396. 412.
	1.50	155	5402.6 5276.6	9.152 9.152	1.3208	.8737 .8654	247	•00)34 •00)28	4.357	441.8	27.260	1.725	425
200.00	¥12												
200.00	•75								6 074	451.4	52.343	1.780	438
200.00 400.00	•30	599	5144.5	9.152	1.1462	.8443	197	•0C)22	5.026				4.46
200.00 400.00 000.00 000.00	•30 •15	500	5062.0	9.152	1.3543	•8300	164	*00) I 8	5.584	457.2	85.868	1.813	443.
200.00 400.00 000.00 000.00	•30		5062.0 4993.2	9.152	1.3543			•00)12 •00)18 •00)55			85.868 141.008	1.813	453
200.00 400.00 000.00 000.00	•30 •15	500	5062.0 4993.2	9.152 9.152	1.3543	•8300 •8407	164	<1(00• 81(00•	5.584	457.2 462.0			453
200.00 400.00 000.00 000.00 000.00	*30 *15 *08	500 417 2915	5062.0 4993.2 R	9.152 9.152 = 0.500 9.891	1.3543 1.3598 . PERCE	.8300 .820/ NT FUEL	164 134 = 20+1	.00)18 .00)12 .2, //F	5.584 6.196 = 3.968	457.2 462.0	141.008	0.000	0.
1.0>	300.00 26>.71	500 417 2915 2809	5062.0 4993.2 R 6769.6 6741.2	9.152 9.152 = 0.500 9.891 9.891	1.3543 1.3598 • PERCE 1.2230 1.2234	.8300 .8207 NT FUEL 1.1020 1.1002	164 134 = 20+1 741 737	.00)18 .00)12 .2. 2/F 0.00100 .00100	5.584 6.196 = 3.968 0.000 .263	457.2 462.0 557.3	2.182	0.000 .204	0.49.
200.00 400.00 000.00 000.00 000.00 1.00 1	300+00 28>+71 290+00	2915 2869 2819	5062.0 4993.2 R 6769.6 6741.2 6664.6	3.155 3.155 3.155 3.155	1.3543 1.3598 PERCE 1.2230 1.2234 1.2246	.8300 .8207 NT FUEL 1.1020 1.1002 1.0723	164 134 = 20+1 741 737 727	.0018 .0012 2. 3/F 0.00100 .00100 .30198	5.584 6.196 = 3.968 0.000 .263	457.2 462.0 557.3 353.4	2.182 1.267	0.000 .204 .391	0 • 49 •
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 20.00 20.00 21.20	2915 2869 2819 2741	5062.0 4993.2 R 6769.6 b741.2 b664.6 b270.5	3.155 3.155 3.155 3.155 3.155 3.155	1.3543 1.3598 PERCE 1.2230 1.2234 1.2246 1.2201	.8300 .8207 NT FUEL 1.1020 1.1002 1.00733 1.0076	164 134 = 20•1 741 737 727 715	.00)18 .00)15 .2.	5.584 6.196 = 3.968 0.000 .243 .250 .752	557.3 353.4 314.7	2.182 1.267 1.065	0.000 .204 .391	0• 49• 95• 129•
200.00 400.00 000.00 000.00 000.00 1.00 1	300+00 28>+71 290+00	2915 2869 2819	5062.0 4993.2 R 6769.6 6741.2 6664.6	3.155 3.155 3.155 3.155	1.3543 1.3594 PERCE 1.2230 1.2234 1.2246 1.2264 1.2273 1.2284	.8300 .8207 NT FUEL 1-1020 1-1002 1-0993 1-0896 1-0896 1-0804	164 134 = 20+1 741 737 727 715 705 697	0.00 18 0.00 15 0.00 100 0.00 100 0.00 100 0.00 198 0.00 198 0.00 198 0.00 198 0.00 198	5.584 6.196 = 3.968 0.000 .243 .250 .752 .894 1.000	457.2 462.0 557.3 353.4 314.7 305.8 304.2	2.182 1.267 1.065 1.011 1.000	0.000 .204 .391 .528 .620 .687	95 129 151 167
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 265.71 200.00 214.29 187.50 167.67	2915 2809 2819 2741 2674 2619 2565	6769-6 6741-2 6004-6 6070-5 6008-5 6088-5	9.152 9.152 = 0.500 9.891 9.891 9.891 9.891 9.891	1.3543 1.3598 PERCE 1.2230 1.2234 1.2246 1.2264 1.2273 1.2284 1.2295	.8300 .8207 NT FUEL 1:1020 1:1002 1:0075 1:00846 1:00846 1:00804 1:0763	= 20+1 741 737 727 715 705 697 689	00018 00012 2+ 2/F 0+00100 00100 00098 00094 00094 00094	5.584 6.196 23.968 0.000 .243 .250 .752 .894 1.000 1.097	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2	2.182 1.267 1.065 1.011 1.000 1.008	0.000 .204 .391 .528 .620 .687 .746	0 49 95 129 151 167 182 182 182 182 182 182 182 182 182 182
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 265.71 200.00 214.29 187.20 167.67	2915 2809 2819 2741 2674 2619	5062+0 4993+2 R 6769+6 6741+2 6604+6 6576+5 6502+9 6446+5	9.152 9.152 = 0.500 9.891 9.891 9.891 9.891 9.891	1.3543 1.3594 PERCE 1.2230 1.2234 1.2246 1.2264 1.2273 1.2284	.8300 .8207 NT FUEL 1-1020 1-1002 1-0993 1-0896 1-0896 1-0804	164 134 = 20+1 741 737 727 715 705 697	0.00 18 0.00 15 0.00 100 0.00 100 0.00 100 0.00 198 0.00 198 0.00 198 0.00 198 0.00 198	5.584 6.196 = 3.968 0.000 .243 .250 .752 .894 1.000	457.2 462.0 557.3 353.4 314.7 305.8 304.2	2.182 1.267 1.065 1.011 1.000	0.000 .204 .391 .528 .620 .687	0494 954 1294 1514 1674 1824
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 285.71 200.00 214.29 187.20 150.00 75.00	2915 2869 2819 2741 2674 2619 2565 2250	6769.6 6769.6 6769.6 6769.5 5007.9 6007.6 5007.9 6446.5 6053.6	9.152 y.152 = 0.500 9.891 y.891 y.691 y.691 y.691 y.691 y.691 y.691	1.3543 1.3598 1.3598 1.2230 1.2234 1.2244 1.2273 1.2284 1.2295 1.2372	.8300 .8207 NT FUEL 1-1020 1-1002 1-0793 1-0696 1-0804 1-0763 1-04/8	= 20+1 741 737 727 715 705 697 689	.00)18 .00)15 .00)15 .00 \00 .00 \00 .00 \94 .00 \94 .00 \94 .00 \94 .00 \94 .00 \94	5.584 6.196 23.968 0.000 .243 .250 .752 .894 1.000 1.097	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2	2.182 1.267 1.065 1.011 1.000 1.008 1.290	0.000 .204 .391 .528 .620 .687 .746	0. 49. 95. 129. 151. 167. 182. 249.
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 265.71 200.00 214.29 187.50 167.67	2915 2809 2819 2741 2674 2619 2565	6769-6 6741-2 6004-6 6070-5 6008-5 6088-5	9.152 9.152 = 0.500 9.891 9.891 9.891 9.891 9.891	1.3543 1.3598 PERCE 1.2230 1.2234 1.2246 1.2264 1.2273 1.2284 1.2295	.8300 .8207 NT FUEL 1:1020 1:1002 1:0075 1:00846 1:00846 1:00804 1:0763	741 737 747 747 747 747 747 747 747 747 747	00018 00012 2+ 2/F 0+00100 00100 00098 00094 00094 00094	5.584 6.196 = 3.968 0.000 .243 .250 .752 .894 1.097 1.600 2.154 2.245	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2 328.4 362.0 383.3	2.182 1.267 1.065 1.011 1.000 1.008 1.290 2.180 3.424	0.000 .204 .391 .528 .620 .687 .746 1.022	0. 49. 95. 129. 151. 167. 182. 249.
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 283.71 200.00 243.71 200.00 214.29 187.20 75.00 75.00	2915 2809 2819 2741 2674 2619 2565 2250 1881 1653	6769.6 6769.6 6741.2 6664.6 6276.2 5604.6 5276.2 6446.5 6385.5 6053.6	9.152 y.152 = 0.500 9.891 y.891 y.691 y.691 y.691 y.691 y.691 y.691	1.3543 1.3598 PERCE 1.2230 1.2234 1.2245 1.2273 1.2274 1.2275 1.2372 1.2372 1.2497 1.2611 1.2615	.8300 .8207 NT FUEL 1-1020 1-1002 1-0093 1-0096 1-0846 1-0804 1-0763 1-0763 1-0764	164 134 20•1 741 737 727 715 697 689 636	0.0018 0.0019 0.0000 0.0009 0.0099 0.0099 0.0099 0.0099 0.00991 0.0099 0.00991	5.584 6.196 2 3.968 0.000 .2d3 .752 .894 1.000 1.097 1.600 2.154 2.945	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2 328.4 362.0 383.3 383.8	2.182 1.267 1.065 1.011 1.000 1.008 1.290 2.180 3.424 3.471	0.000 .204 .391 .528 .620 .687 .746 1.022	00 49 95 129 151 167 182 249 308 341
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 265.71 20.00 214.29 167.67 150.00 75.00	2915 2809 2819 2741 2619 2565 2250 1881 1653	0062.0 4993.2 R 6769.6 0741.2 0004.6 0270.2 0202.9 6380.5 6053.6	9.152 y.152 = 0.500 9.891 y.691 y.691 y.691 9.691 9.891 9.891	1.3543 1.3596 PERCE 1.2250 1.2254 1.2264 1.2273 1.2264 1.2295 1.2372 1.2497 1.2497 1.2497	.8300 .8207 NT FUEL 1-1020 1-1002 1-0046 1-0846 1-0846 1-0763 1-0478	164 134 = 20•1 741 737 727 715 705 697 689 636	0.00 118 0.00 117 2. 2/F 0.00 100 0.00 100 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194 0.00 194	5.584 6.196 = 3.968 0.000 .243 .250 .752 .894 1.097 1.600 2.154 2.245	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2 328.4 362.0 383.3	2.182 1.267 1.065 1.011 1.000 1.008 1.290 2.180 3.424	0.000 .204 .391 .528 .620 .687 .746 1.022	0. 49. 95. 129. 151. 167. 182. 249. 308. 341.
1.00 1.00 1.40 1.40 1.40 1.40 1.79 2.00 4.00 20.41 4.00	300.00 245.71 200.00 214.29 187.50 15.60 75.00 30.00 13.00 14.70 7.50	2915 2915 2809 2819 2741 2679 2565 2250 1881 1653 1627	R 6769+6 0741+2 0004+6 0270+2 0202+3 0440+5 6280+3 0033+6 03424+0 2424+0 2423+1 2210+1	9.152 7.152 = 0.500 9.891 9.091 9.091 9.091 9.091 9.091 9.091 9.091 9.091	1.3543 1.399d PERCE 1.2230 1.2240 1.2240 1.2273 1.2284 1.2295 1.2295 1.2372 1.2497 1.2611 1.2612 1.2614	.8300 .8207 NT FUEL 1-1020 1-1002 1-0095 1-0896 1-0896 1-0896 1-0763 1-0478 1-0095 -9702 -9692 -9692	164 134 741 737 715 705 697 689 636 508 508 508	00118 00117 2• 2/F 0.00100 00100 00198 00198 00199 00191 00191 00191 00191	5.584 6.196 0.000 .283 .250 .752 .894 1.000 1.097 1.600 2.154 2.256 2.731	557.3 557.3 557.3 553.4 514.7 305.8 305.2 328.4 362.0 383.8 401.0	2.182 1.267 1.065 1.011 1.000 1.008 1.290 2.180 3.424 3.471 2.497	0.000 .204 .391 .528 .620 .687 .746 1.022 1.264 1.398 1.401	0. 49. 95. 129. 151. 167. 182. 249. 308. 341. 342.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	300-00 203-71 270-00 214-27 187-20 187-20 157-67 150-00 75-00 10-00 10-75-00	2915 2809 2819 2741 2674 2619 2565 2250 1881 1653	6769.6 6769.6 6741.2 6664.6 6276.2 5604.6 5276.2 6446.5 6385.5 6053.6	9.152 9.500 9.891 9.891 9.691 9.691 9.691 9.691 9.691 9.691 9.691 9.691 9.691	1.3543 1.3598 PERCE 1.2230 1.2234 1.2245 1.2273 1.2274 1.2275 1.2372 1.2372 1.2497 1.2611 1.2615	.8300 .8207 NT FUEL 1-1020 1-1002 1-0093 1-0096 1-0846 1-0804 1-0763 1-0763 1-0764	164 134 20•1 741 737 727 715 697 689 636	0.0018 0.0019 0.0000 0.0009 0.0099 0.0099 0.0099 0.0099 0.00991 0.0099 0.00991	3.968 6.196 0.000 .2d3 .203 .203 .200 .752 .894 1.000 1.097 1.600 2.154 2.256 2.731 3.424 3.673	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2 328.4 362.0 383.3 383.8	2.182 1.267 1.065 1.011 1.000 1.008 1.290 2.180 3.424 3.471	0.000 .204 .391 .528 .620 .687 .746 1.022	0°49° 95° 129° 151° 167° 182° 249° 308° 341° 342° 567° 410°
200.00 400.00 000.00 000.00 000.00 1.00 1	300.00 245.71 200.00 214.29 187.50 15.60 75.00 30.00 13.00 14.70 7.50	2915 2809 2819 2819 2741 2619 2565 2220 1881 1623 1627 1411	R 6769+6 6741+2 660+6 570+3 600 570+3 600 540+6 500 53+6 500 500 53+6 500 500 500 500 500 500 500 500 500 50	9.152 7.152 = 0.500 9.891 7.091 7.091 9.091 9.091 9.091 9.091 9.091 9.091	1.3543 1.3543 PERCE 1.2230 1.2234 1.2261 1.2261 1.2273 1.2264 1.2295 1.2372 1.2615 1.2615 1.2615 1.26144	.8300 .8207 NT FUEL 1.1020 1.1002 1.0075 1.0096 1.0	164 134 = 20•1 741 737 715 705 689 636 506 506 506 506 507 507 508 508 508 508 508 508 508 508 508 508	00 118 00 112 2 2/F 0 00 100 00 100 00 100 00 194 00 194 00 194 00 195 00 194 00 195 00 196 00 196 00 196 00 196 00 196 00 196 00 196	5.584 6.196 0.000 .263 .220 .720 .894 1.000 1.097 1.600 2.154 4.245 4.245 4.295 2.931	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2 328.4 362.0 383.3 383.8 401.0	2.182 1.267 1.065 1.011 1.000 1.290 2.180 3.424 3.421 2.497	0.000 .204 .391 .528 .620 .687 .746 1.022 1.264 1.398 1.504	00 49 95 129 151 167 182 249 308 341 342 567 410 423
1.00 1.00	300-00 265-71 200-00 216-29 187-20 167-67 150-00 75-00 18-70 7-50 30-00 18-70 7-50	2915 2809 2819 2741 2619 2565 2755 1681 1653 1657 1411 1152 981	9062-0 4973-2 R 6769-6 6741-2 6004-6 5070-2 5000-2 6446-5 5086-5 5086-5 5086-5 4422-1 2422-1 4702-7 4034-4 4704-4	9.152 - 0.500 9.891 7.091 7.091 7.091 7.091 7.091 7.091 7.091 7.091 7.091 7.091	1.3543 1.3543 PEKCE 1.2230 1.2234 1.2245 1.2264 1.2273 1.2264 1.2275 1.2511 1.2611 1.2611 1.2613 1.2614 1.2613 1.2614 1.2613 1.2614 1.2613	.8390 .8207 NT FUEL 1-1020 1-1007 1-0096 1-0096 1-0163 1-0496 1-0702 9-092 9-0	164 134 = 20•1 741 737 727 715 697 698 508 508 508 508 508 508 508 508 508 50	.0018 .0019	5.584 6.196 23.968 0.000 .263 .220 1.000 1.097 1.600 2.154 2.295 2.731 3.424 3.673 4.321	457.2 462.0 557.3 353.4 314.7 305.8 304.2 305.2 328.4 362.0 383.3 383.8 401.0 419.9 431.3 440.7	2+182 1-267 1-065 1-011 1-000 1-008 1-290 2+180 3-424 3-471 2-497	0.000 .c04 .991 .528 .620 .687 .746 1.022 1.264 1.398 1.401 1.504	0° 49° 95° 129° 151° 167° 182° 249° 308° 341° 367° 394° 410° 423°
1.00 1.00 1.00 1.00 1.20 1.40 1.40 1.40 1.40 1.40 1.79 2.00 4.00 10.00 20.41 40.00 20.00 20.00	300-00 289-71 200-00 214-29 187-20 167-67 150-00 75-00 30-00 11-70 7-20	2915 2809 2819 2741 2619 2565 2250 1881 1627 1411	2062-0 4973-2 R 6769-6 0741-2 0004-6 0270-2 0202-9 0440-5 6380-5 0053-6 0053-6 0427-8	9.152 - 0.500 9.891 9.891 9.091	1.3543 1.3543 PEKCE 1.2230 1.2234 1.2245 1.2264 1.2273 1.2372 1.2372 1.2497 1.2011 1.2013 1.2014 1.2013 1.2014 1.2015	.8390 .8207 NT FUEL 1.1020 1.1007 1.0070 1.0080 1.0080 1.0163 1.0070 .9702 .9092 .9392 .8848 .8216	164 134 = 20•1 741 737 727 715 705 997 689 036 908 908 908 908 908 908 908 908 908 908	00018 00010 00000 0000 0009 00094 00094 00091 00091 00091 00091	3.968 6.196 0.000 .2d3 .203 .203 .200 .752 .894 1.000 1.097 1.600 2.154 2.256 2.731 3.424 3.673	457.2 464.0 557.3 353.4 314.7 305.8 304.2 328.4 362.0 383.3 383.3 383.6 401.0 419.9	2.182 1.267 1.065 1.011 1.000 1.008 1.290 2.180 3.424 3.471 5.497	0.000 .c04 .991 .528 .620 .687 .746 1.022 1.264 1.998 1.401 1.504	0°49° 95° 129° 151° 167° 182° 249° 308° 341° 342° 567° 410°

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(g) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio, P _c /P	Static pressure, P, lb/sq in. abs	Temp- erature T, "K	Enthalpy, h,	Molecular weight,	Isentropic exponent,	Specific heat, c _{p,}	Viscos- ity,	Thermal conductivity, k, cal/(sec)(°K)(cm)	Mach number M	Specific impulse in vacuum I vac. [fb](sec]/fb	Area , ratio, E	Thrust coefficient C _F	Specific impulse I, ;(b)(sec)/i
		1		R = 0.60	I D. PERCE	NT FUEL		1 35, Q/F	= 4=76.	4	i	1	
1.00	300•00		5841.6	11.290	1.2131	1.0021	796	0.00097	0.000			0.000	0.
1.05	285•71 250•00	3128	5742.0	11.290	1.2134	1.0008	793	•00097 •00095	•284 •552	344.4	1.264		45. 93.
1.40	214.29	2973	5660.2	11.290	1.2106	.9924	771	•00093	.755	306.0	1.063	.547	125.
1.60	187.50 168.29	2903	5591.2 5536.4	11.290	1.21/0	.9883 .9849	753	•00092	.898	298.2	1.010	.019	. 447.
2.00	150.00		5479.4	11.290	1.2186	.9813	744	100089	1.000	296.0	1.000	.744	162.
4.00	75.00	2460	5159.5	11.290	1.2249	•9585	692	•00082	1.604	320.9		1.021	243
10.00	30.00	2073	4794.7	11.290	1.4 174	. 9238	621	•00071	2.155	354.4	2.204	1.265	301.
20.00	15.00	1812	4558.0	11.290	1.2452	8940	565	•00063	2.542	375.7	: 3.481		334.
20.41 40.00	14.70 7.50	1805	4551.5 4351.5	11.290	1.2455	.8930 .8622	264 209	•00063	2.354	376.3 393.6	3.530	1.404	335.
				110270	1.2505	•0022	207	•00055	2.723	3,5,0	>.624	1.5009	360.
200.00	3.00 1.50	1302	4119.9 3972.5	11.290	1.2742	.8176 .7001	433	-00045	3.434	412.0	10.795	1.622	387.
400.00	.75	954	3846.3	11.290	1.3038	.7254	325	•00038 •00032	3.839 4.270	424.5	17.794 29.396	1.691	403.
1000.00		767	22-0										
2000.00	•30 •15	646	3708.0	11.290	1.3218	•7230 •7044	262 220	•00025 •00020	4.891 5.411	444.5	57.125 94.401	1.842	430.
4000.00	•08	542	3549.6	11.290	1.3427	•6076	183	•00017	5.980	455.9	155.954	1.872	446.
			н	= 0.700	• PERCE	NT FUEL	= 15.2	5. 0/F	= 5.556		1		
1.00	300.00	3307	5138.3	12.574	1.2069	0.9217	836		0.000		T		
1.05	285.71	3280	5112.9	12.574	1.2073	.9205	832	•00094	.285	526.7	2.172	0.000 203	0. 47.
1.20	250•00 214•29	3205	5044.5 4967.4	12.574 12.574	1.2082	-9172	822	•00092	• > 54	334.3	1.262	.390	90+
1.60	187.50	3121 3049	4902.3	12.574	1.2101	•9136 •9103	610 800	•00090 •00089	•757 •700	297.9	1.062	.526	121.
1.78	168.68	2994	4851.8	12.574	1.2109	•9075	192	•00008	1.000	200.5	4.000	•681	157.
2.00 4.00	150.00 75.00	2933 2595	4796.8 4494.4	12.574	1.2118	•9044 •8847	160	•00086 •00079	1.103	269.4 312.1	1.009 1.300	1.021	236.
- 1	;	!						•000,		312.1	1.500	1.021	2300
10.00 20.00	30 • 00 15 • 00	2197 1930	4148.0 3922.2	12.574	1.2267	.6221 .8299	600	•00070	2.156	345.0 366.1	2.220 3.518	1.266	293.
20.41	14.70	1922	3916.0	12.574	1.2355	8290	603	•00062 •00062	2.052	355.5	3.567	1.405	325+1 326+1
40.00	7.50	1687	3724.3	12.574	1.2405	.8017	546	•00055	2.918	383.8	5.705	1.513	350.
100.00	3.00	1402	3501.1	12.574	1.2618	.7618	473	•00345	3.422	403.0	11.013	1.628	377.4
400.00	1.50	1211	3358.2 3235.2	12.574	1.2757	•7312 •7018	416 361	•00039	3.819 4.238	414.7	18.240	1.697	393.6
	•,,	1033	253742	12.574	1.2700	. 7010	361	•00032	4.230	424.5	30.278	1.755	400.5
2000.00	•30 •15	841 712	3099.5	12.574	1.3096	.6684 .6478	294 248	+00025 +00021	4.841 5.343	434.9 441.2	59.186	1.816	421.1
4000-00	.0a	600	2943.0	12.574	1.3336	6318	207	•00021	5.894	440.0	96.189 162.738	1.885	437.1
			Α	= 0.800	• PERCE	NT FUEL		0- 0/5	= 6.349				
1 00	200.00	3393							- т	1	. 1	1	
1.00	300.00 285.71	3365	4586.9 4563.0	13.740	1.2033	0.8561 .8551	864 860	0.00090	0.000 -285	510.4	2.170	0 • 000 • 202	45.5
1.20	250.00	3290	4498.8	13.740	1.2044	.8522	849	.00088	•555	324.0	1.261	-389	87.6
1.40	214.29 187.50	3204 3132	4426.4	13.740	1.2054	.8488 .8460	837	•00086 •00085	•758 •901	288.8 280.8	1.062	•525 •617	118.7
1.78	168.91	3077	4318.3	13.740	1.2069	.8437	819	.00084	1.000	279.5	1.009	.680	152.9
2.00	150.00	3015 2673	4266.0 3981.2	13.740	1.2077	•8409	810	•00083	1.104	280.6	1.009	.743	167.
4.00	75.00	2013		13.140	1.2131	.8234	758	•00076	1.607	302.8	1.303	1.021	229.6
10.00	30-00	2270	3654.3	13.740	1.2216								
				10 7		• 7974	687	•00067	2.157	335.0	2.229	1.266	
20.00	15.00	1998	3440.7	13.740	1.2294	•7750	632	•00060	2.540	355.6	3.539	1.266	310.8
20.41			3440.7 3434.8 3252.9	13.740 13.740 13.740								1.266	315.8
20.41	15.00 14.70 7.50	1998 1990 1752	3434.8 3252.9	13.740 13.740 13.740	1.2294 1.2297 1.2391	•7750 •7743 •7496	632 630 575	•00060 •00053	2.540 2.551 2.915	355.6 356.2 373.0	3.539 3.590 5.753	1.266 1.404 1.408 1.515	315.6 316.6 340.7
20.41 40.00 100.00 200.00	15.00 14.70 7.50 3.00 1.50	1998 1990 1752 1462 1266	3434.8 3252.9 3040.4 2903.8	13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676	.7750 .7743 .7496	632 630 575 499 441	•00060	2.551;	355.6 356.2	3.539 3.590	1.266 1.404 1.408	315.6 316.6 340.7
20.41 40.00	15.00 14.70 7.50	1998 1990 1752 1462	3434.8 3252.9 3040.4	13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542	•7750 •7743 •7496	632 630 575 499	•00060 •00053 •00045	2.540 2.551 2.915 3.416	355.6 356.2 373.0	3.539 3.590 5.753	1.266 1.404 1.408 1.515	284.9 315.8 316.6 340.7 366.8 382.7 395.9
20.41 40.00 100.00 200.00 400.00	15.00 14.70 7.50 3.00 1.50	1998 1990 1752 1462 1266	3434.8 3252.9 3040.4 2903.8 2785.9	13.740 13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676	.7750 .7743 .7496	632 630 575 499 441	.00060 .00060 .00053 .00045 .00038	2.540 2.551 2.915 3.416 3.808	355.6 356.2 373.0 391.9 403.5	3.539 3.590 5.753 11.146 18.514 30.827	1.266 1.404 1.408 1.515 1.631 1.701	315.8 316.6 340.7 366.8 382.7 395.9
20.41 40.00 100.00 200.00 400.00	15.00 14.70 7.50 3.00 1.50 .75	1998 1990 1752 1462 1266 1091 887 753	3434.8 3252.9 3040.4 2903.8 2785.9 2655.2 2573.1	13.740 13.740 13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153	.7750 .7743 .7496 .7136 .6852 .6572 .6243	632 630 575 499 441 385 316 268	.00060 .00060 .00053 .00045 .00038 .00032	2.540 2.551 2.915 3.416 3.808 4.220 4.811 5.303	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9	3.539 3.590 5.753 11.146 18.514 30.827 60.499 100.640	1.266 1.404 1.408 1.515 1.631 1.701 1.760	315.6 316.6 340.7 366.8 382.7 395.9 410.0
20.41 40.00 100.00 200.00 400.00	15.00 14.70 7.50 3.00 1.50 .75	1998 1990 1752 1462 1266 1091	3434.8 3252.9 3040.4 2903.8 2785.9	13.740 13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822	.7750 .7743 .7496 .7136 .6852 .6572	632 630 272 499 441 385	.00060 .00060 .00053 .00045 .00038 .00032	2.540 2.551 2.915 3.416 3.808 4.220 4.811	355.6 356.2 373.0 391.9 403.5 413.2	3.539 3.590 5.753 11.146 18.514 30.827	1.266 1.404 1.408 1.515 1.631 1.701 1.760	315.6 316.6 340.7 366.8 382.7 395.9 410.0
20.41 40.00 100.00 200.00 400.00	15.00 14.70 7.50 3.00 1.50 .75	1998 1990 1752 1462 1266 1091 887 753	3434.8 3252.9 3040.4 2903.8 2785.9 2655.2 2573.1 2503.6	13.740 13.740 13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272	.7750 .7743 .7496 .7136 .6852 .6572 .6243	632 630 575 499 441 385 316 268 226	.00060 .00060 .00053 .00045 .00038 .00032 .00025 .00021	2.540 2.551 2.915 3.416 3.808 4.220 4.811 5.303	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9	3.539 3.590 5.753 11.146 18.514 30.827 60.499 100.640	1.266 1.404 1.408 1.515 1.631 1.701 1.760	315.6 316.6 340.7 366.8 382.7 395.9 410.0
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	15.00 14.70 7.50 3.00 1.50 .75 .30 .15 .08	1998 1990 1752 1462 1266 1091 887 753 636	3434.8 3252.9 3040.4 2903.8 2785.9 2655.2 2573.1 2503.6	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCEC	.7750 .7743 .7496 .7136 .6852 .6572 .6243 .6034 .5867	632 630 575 499 441 385 316 268 226 = 12.2	.00060 .00060 .00053 .00045 .00038 .00032 .00025 .00021 .00017	2.540 2.551 2.915 3.416 3.808 4.220 4.811 5.303 5.841 = 7.143	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2	3,539 3,550 5,753 11,146 18,514 30,827 60,499 100,640 167,192	1.266 1.404 1.408 1.515 1.631 1.701 1.760 1.823 1.861 1.893	310-6 316-6 340-3 366-8 382-3 395-8 410-0 418-6 425-8
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	300.00 285.71	1998 1990 1752 1462 1266 1091 887 753 636	3434.8 3252.9 3040.4 2903.8 2785.9 2655.2 2573.1 2503.6	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCEI	.7750 .7743 .7496 .7136 .6852 .6572 .6243 .6034 .5867 .T FUEL:	632 630 575 499 441 385 316 268 226 = 12.2	.00060 .00060 .00060 .00053 .00045 .00038 .00032 .00025 .00021 .00017	2-540 2-551 2-915 3-416 3-808 4-220 4-811 5-303 5-841 7-143 0-000 -286	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2	3.539 3.590 5.753 11.140 18.514 30.827 60.449 100.640 167.192	1.266 1.404 1.408 1.515 1.631 1.701 1.760 1.823 1.861 1.893	310-6 316-6 340-3 366-8 382-3 395-8 410-0 418-6 425-8
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	300.00 285.71 250.00 200.00 285.71 250.00 214.29	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242	3434.8 3252.9 3040.4 2903.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCEC	.7750 .7743 .7496 .7136 .6852 .6572 .6243 .6034 .5867 VI FUEL:	032 630 575 499 441 385 316 268 226 = 12.2 083 d79 858 859	-0060 -00060 -00053 -00045 -00038 -00032 -00021 -00017 8, 0/F	2.540 2.551 2.915 3.416 3.808 4.220 4.811 5.303 5.841 -7.143	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2	3,539 3,539 3,590 5,753 11,140 18,514 30,827 60,440 100,640 167,192	1.266 1.404 1.408 1.515 1.701 1.700 1.823 1.861 1.893	310-6 316-6 340-3 366-8 382-3 390-9 410-0 418-6 425-8
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	15.00 14.70 7.50 3.00 1.50 .75 .30 .15 .08	1998 1990 1752 1462 1266 1091 887 753 636	3434.8 3252.9 3040.4 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2 3934.7	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCE	.7750 .7743 .7446 .7136 .6852 .6572 .6243 .6034 .5867 VI FUEL .8019 .8010 .7983 .7753 .7753	032 630 272 499 441 385 316 268 426 = 12.2 083 079 856 046	-00060 -00060 -00053 -00045 -00038 -00032 -00021 -00017 -00017 -00065 -00064 -00064 -00064	2.940 2.951 3.416 3.808 4.220 4.811 5.303 5.841 7.143 0.000 .286 .255 .759 .901	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 494.7 314.0 280.0 272.2	3,539 3,539 3,590 5,753 11,146 18,514 30,827 60,499 100,640 167,192	1.266 1.404 1.408 1.515 1.701 1.701 1.823 1.861 1.893	315-8 316-8 340-3 366-8 382-3 395-8 410-0 418-8 425-8
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 285-71 250-00 244-27 187-50 169-04 150-00	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242 3169 3169 3169 3169	3434.8 3252.9 3040.4 2903.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCE: 1.2013 1.2016 1.2024 1.2033 1.2041 1.2047 1.2047	.7750 .7743 .7496 .7136 .6852 .6572 .6243 .6034 .5867 VI FUEL:	032 630 575 499 441 385 316 268 226 = 12.2 083 d79 858 859	-0060 -00060 -00053 -00045 -00038 -00032 -00021 -00017 8, 0/F	2.540 2.551 2.915 3.416 3.808 4.220 4.811 5.303 5.841 -7.143	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2	3,539 3,559 5,753 11,140 18,514 30,827 60,449 100,640 167,192	1.266 1.404 1.408 1.515 1.701 1.700 1.823 1.861 1.893	310-6 316-6 340-7 366-8 382-7 382-7 382-7 410-0 418-6 425-8 44-7 84-7 1134-6 1140-1
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.60 1.77	300.00 255.71 300.00 1.50 .75 .30 .15 .08	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242 3169 3114	3434.8 3252.9 3040.4 42903.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2 3934.7 3890.9	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.785 14.785	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCEL 1.2013 1.2016 1.2024 1.203 1.2041 1.2041	.7750 .7743 .7496 .7136 .6852 .6572 .6243 .6034 .5867 .7 FUEL	632 630 575 499 441 385 316 266 266 266 266 279 868 879 868 879 868 879 868 879 868 879 868 879 868 879 868 879 868 879 879 879 879 879 879 879 879 879 87	-0060 -00060 -00053 -00045 -00038 -00032 -00025 -00021 -00017 8, O/F	2.940 2.951 2.915 3.416 3.808 4.220 4.811 5.303 5.841 7.143 0.000 2.26 	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 494.7 314.0 280.0 272.2 271.0	3.539 3.559 3.559 3.559 11.146 15.514 30.627 100.640 167.192 2.169 1.261 1.002 1.000	1.266 1.404 1.408 1.515 1.631 1.700 1.823 1.861 1.893 0.000 .202 .389 .529 .617	315-8 316-6 340-3 360-8 382-3 382-3 410-0 418-6 425-8 114-5 114-5 114-5 114-5 114-5 114-5
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.60 1.77 2.00 4.00 1.00 1.00	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 245-71 250-00 214-29 167-00 159-04 150-00 75-00	1998 1990 1752 1462 1266 1091 887 753 636 3402 3327 3242 3169 3114 3051 2706	3434.8 3252.9 3040.4 2503.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2 3992.2 3994.4 3573.5	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.769 14.769 14.769 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCEC 1.2013 1.2016 1.2024 1.2023 1.2047 1.2047 1.2029 1.2108	.7729 .7749 .7749 .7496 .7136 .6852 .6572 .6243 .6034 .5867 .7 FUEL .7 .7 FUE	632 630 773 499 441 385 316 268 226 = 12 • 2 083 d79 808 809 809 809 809 809 809 809 809 80	.00060 .00060 .00063 .00045 .00038 .00025 .00021 .00017 8. O/F: .00040	2-540 2-551; 2-515; 3-446 3-808 4-220 4-811 5-303 5-841 5-303 0-000 2-26 2-25 2-5 2-7 1-000 1-105 1-608	355.6 373.0 391.9 403.5 413.2 423.6 429.9 435.2 494.7 314.0 280.0 272.2 271.0 272.1 293.7	3.539 3.590 3.590 3.753 11.146 18.514 30.827 60.499 100.640 167.192	1.266 1.404 1.408 1.515 1.701 1.700 1.823 1.861 1.893 0.000 202 389 525 617 679 743	310-6 316-6 340-7 366-8 382-7 340-0 410-0 425-8 0-0 114-5 134-6 114-6 1162-0 222-6
20.41 40.00 100.00 200.00 400.00 1000.00 1000.00 1.00 1.00 1	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 285-71 250-00 244-27 187-50 15-00 75-00 30-00 15-00	1996 1990 1752 1462 1266 1091 887 753 636 3430 33402 3327 3242 3169 3114 3051 2706 2303 2030	3434.8 3252.9 3040.4 2503.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3592.2 3534.7 3592.2 3534.7 3573.5 364.8 3573.5	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.740 14.769 14.769 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 1.2013 1.2016 1.2024 1.2024 1.2035 1.2041 1.2035 1.2041 1.2035 1.2041 1.2035 1.2041 1.2035	.7729 .7749 .7749 .7136 .6852 .6572 .6572 .6243 .6034 .5867 .5867 .5867 .5867 .7928 .7928 .7928 .7928 .7928 .7928 .7928 .7928 .7928 .7928 .7928 .7928 .7928	632 630 573 499 441 385 316 268 226 226 226 237 808 808 808 808 808 808 808 808 808 80	.00060 .00060 .00063 .00045 .00038 .00025 .00021 .00021 .00021 .00061 .00062 .00064 .00062 .00061 .00073	2-540 2-515 3-416 3-808 4-220 4-811 5-303 5-841 -7-143 0-000 -256 -55 -759 -901 1-000 1-105 1-008 2-157 2-167 2-1	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 449.0 240.0 271.0 271.0 271.0 271.1 293.7	3.539 3.590 5.753 11.140 10.514 30.827 60.499 100.640 167.192	1.266 1.404 1.408 1.515 1.631 1.701 1.760 1.861 1.863 1.863 1.863 1.863 1.863 1.863 1.873 1.774 1.773 1.774	315-8 316-8 340-3 366-8 342-3 342-3 342-3 410-0 418-8 425-8 44-9 114-9 114-9 114-9 114-9 114-9 226-3 276-3
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.60 1.77 2.00 4.00 20.0	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 245-71 250-00 214-29 167-00 159-04 150-00 75-00	1998 1990 1752 1462 1266 1091 887 753 636 3402 3327 3242 3169 3114 3051 2706	3434.8 3252.9 3040.4 2703.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2 3992.2 3934.7 3573.5 3265.6 3064.0	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3153 1.3272 PERCE 1.2013 1.2024 1.2024 1.2024 1.2027 1.2027 1.2027 1.2027 1.2027 1.2028 1.2028 1.2028	-7790 -7749 -7749 -7196 -6952 -6972 -6243 -634 -5867 -7867 -7883 -7926 -7906 -7801 -7722 -7486 -725 -725	632 630 570 499 441 385 316 268 426 = 12 • 2 083 079 030 030 030 030 030 030 030 030 030 03	.00060 .00060 .00063 .00045 .00032 .00025 .00021 .00017 8, O/F: .00042 .00042 .00042 .00043	2-940 2-951 3-416 3-808 4-220 4-811 5-303 5-841 0-000 2-000 1-100 1-000 1-100 1-008 2-157 2-940 2-951	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 444.7 314.0 280.0 272.2 271.0 272.1 293.7 325.0 345.1 345.1 345.1	3.539 3.590 5.753 11.140 18.514 30.827 60.499 100.640 167.192 2.169 1.004 1.000 1.010 1.304 2.234 3.551 3.652	1.266 1.404 1.408 1.515 1.631 1.701 1.701 1.823 1.861 1.893 1.861 1.893 1.607 202 202 389 527 617 743 1.020	310-6 316-6 340-3 360-8 382-3 382-3 382-3 410-0 425-8 44-5 114-5 114-5 114-5 114-5 114-5 114-5 114-5 114-5 114-6 1
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.60 1.77 2.00 4.00 1.00 2.00 4.00	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 285-71 250-00 214-29 187-50 187-50 30-00 75-00 75-00	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242 3164 3051 2706 2303 2030 2023 1783	3434.8 3252.9 3040.4 2703.8 2785.9 2655.2 2573.1 2503.6 8 4142.9 4120.6 4060.2 3992.2 3992.2 3992.2 3934.7 3534.7 3534.7 3565.6 3064.0 3064.0	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2622 1.3015 1.3272 PERCE 1.2013 1.2016 1.2024 1.2024 1.2031 1.2047 1.2047 1.2106 1.2	.7720 .7749 .7749 .7149 .7149 .6152 .6243 .6035 .6572 .6243 .6036 .7867 .7883 .7926 .7906 .7905 .7906 .7906 .7906 .7906 .7406	632 630 772 499 441 385 316 266 266 276 83 878 878 878 878 877 878 878 878 878	.00060 .00060 .00063 .00045 .00032 .00025 .00021 .00017 8. O/F: .00062 .00062 .00062 .00063 .00073 .00073	2-940 2-951 3-416 3-808 4-220 4-811 5-303 5-841 5-303 5-841 1-1000 1-1000 1-1000 1-1000 1-1008 2-1000 1-1008 2-1008 2-1008 2-1008	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 424.0 429.9 435.2 271.0 470.0	3.539 3.590 5.753 11.140 18.514 30.827 60.499 100.640 167.192 2.169 1.002 1.002 1.003 1.000 1.310 2.234 3.551 3.652 5.780	1.266 1.404 1.408 1.408 1.408 1.701 1.701 1.823 1.883 1.883 1.893 0.000 202 202 389 9.74 617 617 1.720 1.267 1.405 1.405 1.405 1.405	310-6 316-6 346-8 346-8 342-8 418-6 425-8 44-1 114-5 114-5 124-6 226-3 306-4 307-2 330-6
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.60 1.77 2.00 4.00 20.41 40.00	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 285-71 250-00 224-27 167-50 169-04 150-00 75-00 14-70 7-50 15-00 15-00 15-00 15-00 15-00 15-00 15-00 15-00 15-00 169-00	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242 3169 3114 2706 2303 2033 2033 2033 1783	3434.8 3252.9 3040.4 2503.8 2785.9 2655.2 2573.1 2503.6 R 4142.9 4120.6 4060.2 3992.2 334.7 399.7 3841.4 3573.5 3265.6 3064.0 308.4 2885.4	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.769 14.769	1.2294 1.2297 1.2391 1.2542 1.2626 1.2622 1.3015 1.3153 1.3212 1.2016 1.2016 1.2024 1.203 1.2041 1.205 1.205 1.2168 1.205 1.2168 1.205 1.2168 1.205 1.2168 1.205 1.2061	.7720 .7749 .7749 .71496 .7136 .6052 .6572 .6243 .6034 .5967 .71 FUEL .0.8019 .8010 .7883 .7923 .7926 .7906 .7801 .7422 .7421 .7421 .7421 .7421 .7421	632 630 772 499 441 385 316 268 276 808 808 808 808 808 808 808 808 808 80	.00060 .00060 .00063 .00045 .00038 .00038 .00025 .00021 .00017 .00017 .00064 .00064 .00064 .00069 .00079 .00079 .00078 .00078 .00078	2-940 2-951 2-915 3-416 3-808 4-220 4-811 5-303 5-841 7-143 0-000 -2-56 -2-55 -7-59 -901 1-000 1-105 1-608 2-157 2-940 2-9	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 494.7 314.0 280.0 272.2 271.0 272.1 293.7 345.7 362.2	3.539 3.590 5.753 11.140 10.514 30.827 60.499 100.640 167.192 2.169 1.261 1.009 1.261 1.009 1.261 1.009 1.261 1.304 2.234 3.551 3.602 5.780	1.266 1.404 1.408 1.515 1.701 1.700 1.823 1.861 1.893 0.000 .202 .389 .525 .617 .679 .743 1.020 1.405 1.405 1.405 1.406 1.516	310-6 316-6 340-6 340-6 340-6 340-6 418-6 425-8
20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.60 1.77 2.00 4.00 1.00 2.00 4.00	15-00 14-70 7-50 3-00 1-50 -75 -30 -15 -08 300-00 285-71 250-00 214-29 187-50 187-50 30-00 75-00 75-00	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242 3164 3051 2706 2303 2030 2023 1783	3434.8 3252.9 3040.4 2703.8 2785.9 2655.2 2573.1 2503.6 8 4142.9 4120.6 4060.2 3992.2 3992.2 3992.2 3934.7 3534.7 3534.7 3565.6 3064.0 3064.0	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2622 1.3015 1.3272 PERCE 1.2013 1.2016 1.2024 1.2024 1.2031 1.2047 1.2047 1.2106 1.2	.7720 .7749 .7749 .7149 .7149 .6152 .6243 .6035 .6572 .6243 .6036 .7867 .7883 .7926 .7906 .7905 .7906 .7906 .7906 .7906 .7406	632 630 772 499 441 385 316 266 266 276 83 878 878 878 878 877 878 878 878 878	.00060 .00060 .00063 .00045 .00032 .00025 .00021 .00017 8. O/F: .00062 .00062 .00062 .00063 .00073 .00073	2-940 2-951 3-416 3-808 4-220 4-811 5-303 5-841 5-303 5-841 1-1000 1-1000 1-1000 1-1000 1-1008 2-1000 1-1008 2-1008 2-1008 2-1008	355.6 356.2 373.0 391.9 403.5 413.2 423.6 429.9 435.2 424.0 429.9 435.2 271.0 470.0	3.539 3.590 5.753 11.140 18.514 30.827 60.499 100.640 167.192 2.169 1.002 1.002 1.003 1.000 1.310 2.234 3.551 3.652 5.780	1.266 1.404 1.408 1.408 1.408 1.701 1.701 1.823 1.883 1.883 1.893 0.000 202 202 389 9.74 617 617 1.720 1.267 1.405 1.405 1.405 1.405	315.8 316.6 340.7 366.8 382.7
20.41 40.00 100.00 200.00 400.00 1000.00 1000.00 1.00 1.20 1.20 1.40 1.77 2.00 10.00 20.41 40.00 20.41 40.00 20.60 20.60 20.60	300.00 15.00 1.50 1.50 1.50 1.50 1.50 1.5	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 33247 3242 3169 3114 2700 2033 1783 1783 1783	3434.8 3252.9 2503.8 2785.9 2655.2 2573.1 2503.6 8 4142.9 4120.6 4060.2 3992.2 3992.2 3992.2 3934.7 3058.4 250.6 3058.4 250.6	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3272 PERCE: 1.2013 1.2016 1.2024 1.2024 1.2024 1.2025 1.2106 1.2106 1.2024 1.2025 1.2027 1.	.7720 .7749 .7749 .7149 .7149 .6152 .6243 .6035 .6243 .6036 .5867 .7867 .7888 .7926 .7989	032 / 630 /	.00060 .00060 .00063 .00045 .00032 .00025 .00017 8.	2-540 2-551 2-515 2-515 3-416 3-808 4-811 5-303 5-841 5-303 1-000 1-000 1-000 1-008 2-157 2-540 2-	355.6 356.2 373.0 391.2 403.0 413.2 423.6 429.9 435.2 435.2 471.0 472.2 471.0 472.2 471.0 472.2 471.0 472.2 473.7 345.1 345.1 345.1 345.1 345.1 345.2 470.6 470.1 345.1 345.1	1.140 18.140 18.140 18.140 18.140 18.140 100.440 107.142 2.160 1.002 1.000 1.000 1.304 2.234 3.512 3.512 3.512 3.512 3.512 3.780	1.266 1.404 1.408 1.408 1.408 1.701 1.701 1.823 1.883 1.883 1.893 0.202 2.02 3.893 5.22 6.17 6.79 7.74 1.020 1.267 1.405 1.406 1.516	310.6 310.6 310.7 360.8 342.3 342.3 342.3 342.3 4425.8 4425.8 4425.8 34.9 1140.2 1240.6 226.6 307.2 306.4 307.2 306.6 30
20.41 40.00 100.00 200.00 400.00 1000.00 1000.00 1000.00 1.00 1	300.00 14.70 7.50 3.00 1.50 .75 .80 .15 .08 300.00 285.71 250.00 214.22 187.50 159.00 75.00 30.00 15.00 14.70 75.00	1998 1990 1752 1462 1266 1091 887 753 636 3430 3402 3327 3242 3169 3327 3242 3169 3203 2030 2023 1783 1451	3434.8 3252.9 2503.8 2785.9 2655.2 2573.1 2503.6 8 4142.9 4120.6 4060.2 3992.2 3992.2 3992.2 3934.7 3058.4 2505.6	13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 13.740 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789 14.789	1.2294 1.2297 1.2391 1.2542 1.2676 1.2822 1.3015 1.3272 PERCE: 1.2013 1.2016 1.2024 1.2024 1.2024 1.2025 1.2106 1.2106 1.2024 1.2025 1.2027 1.	-7729 -7749 -7749 -7749 -7136 -6852 -6572 -6572 -6572 -7667 -7745	632 630 777 499 441 385 316 426 426 12.2 083 479 808 808 808 808 808 808 808 808 808 80	.00060 .00060 .00063 .00045 .00038 .00025 .00021 .00017 .00017 .00064 .00064 .00064 .00069 .00069 .0007 .0007 .0007 .0007 .0008 .0007 .0008 .0009 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .000	2-540 2-551 2-515 2-515 3-416 3-808 4-811 5-303 5-841 5-303 1-000 1-	355.6 356.2 373.0 391.2 403.3 413.2 423.6 429.9 435.2 435.2 271.0 280.0 272.2 271.0 272.2 271.0 345.7	1.140 18.140 18.140 18.140 18.140 18.140 100.440 100.440 11.004 1.004 1.000 1.000 1.000 1.304 2.234 3.512 3.512 3.512 3.780	1.266 1.408 1.408 1.515 1.701 1.701 1.823 1.861 1.893 0.000 .202 .389 .525 .617 .679 .743 1.020 1.267 1.405 1.405 1.516	310-63 340-3 340-3 340-3 340-3 340-3 340-3 340-3 340-3 440-1 440-1 144-3 144-1

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID TO YGEN

(g) Continued. Combustion-chamber pressure, 300 pourds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio.	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	exponent,	Specific heat, c _p ,	Viscos- ity, µ,	Thermal conductivity k,	Mach number M	Specific impulse in vacuum,		Thrust coefficient, C _f	1.
P _c /P	lbi/sqin ados	ĸ	col/g	300	γ	col/(gi/°K)	micro poises	col/Isecil®K)(cr	· ~	(lb:/sect/lb	ε		illb)(sec)/illb
	•			= 1.000	. PERCE	NT FJEL	= 11.	19. U/F	= 7.93	7			
							896	1		·	T	0.000	0.0
1.00	300-00 285.71	3437 3409	3777.9	15.734 15.734	1.2004	0.7565	896	0.0008	0.000	: 480 · i	2.168	.202	
1.05	250.00		3699.9	15.734	1.2014	.7533		•0008(.555	304.8	1.260	. 389	82.4
1.40	214.29	3248	3635.9	15.734	1.2023	.7400	959	.000/f	.759		1.062	•525 •617	111.2
1.00	187.50 169.10	3176	3540.6	15.734	1.2038	.7461	850	•0007	1.000	263.0	1.000	•679	143.7
2.00	150.00	3058	3493.9	15.734	1.2045	.7439	841	•0007t	1.105		1.305	.742 1.020	157.2 216.1
4.0C	70.00	2715	3241.4	15.734	1.2095	.7291	787	•00070	1.608	200.1	1.303	1.020	210.1
10.00	30.00	2311	2951.0	15.734	1.2175	•7070	714	•00062	2.157	315.6	2.236	1.267	268.2
10.00	15.00	2039	2760.8	15.734	1.2249	.6819 .6813	657	•00056 •00056	2.240	335.1 335.7	3.557	1.405	297.5 298.3
40.00	14.70 7.50	2031	2755.6	15.734	1.2251	.6663	601		2.913	351.7	5.792	1.516	321.0
70.00			İ		1				3.410	369.7	11.253	1.633	345.8
100.00	3.00 1.50	1500		15.734 15.734	1.2481	.6354 .6104	525 467	•00042 •00036	3.799		18.738	1.705	360.9
200.30	• 75		2174.5	15.734	1.2749	.5857	410	•00031	4.206		31.282	1.764	373.5
							340	-00024	4.788	400+1	61.611	1.828	367.0
ნყ6•00 ივი•აპ:	• • • • • • • • • • • • • • • • • • • •	919	2056.5	15.734	1.3003	•5556 •5360	291				102.755	1.867	395.3
000000	•30	603	1902.2 1919.0	15.734	1.3209	.5195	246		5.798		171.104	1.899	402.2
				. = 1.500	L PERCE	ENT FUEL	 ≃ 7•	749. 0/1	=11.90	5			
		Γ	,		т	т			·			0.000	0.0
1.00	300.00 285.71	3297 3270	2626.1 2509.6	19.320	1.2021	0.6117	915	0.00061	0.000	424.3	2.169	.202	37.9
1.05	285.71	3270	2565.2	19.320	1.2032	•6090	904	.0006	.555	269.4	1.261	.389	72.8
1.40	214.29	3115	2515.1	19.320	1.2041	.6068 .6047	829	•0006	.758 .901		1.062	•525 •617	98.2
1.63	187.50 168.99	3045	2472.8	19.320	1.2056	.6030	869	•0006	1.000	232.4	1.000	•679	127.0
2.00	150.00	2931	2404.3	19.320	1.2005	•6011		•0006	1.104		1.009	.743 1.020	138.9
4.00	75.00	5600	2207.3	19.320	1.2117	.5888	900	•0005	1.608	251.5	1.000	1.020	
10.00	30.00	2210	1981.0	19.320	1.2200	.5/05	124	•000>	2.157		2.232	1.266	236.9
40.00	15.00	1947	1032.9	19.320	1.2275	.5250	665	•0004° •0004°	2.540		3.546 3.597	1.404	263.4
40.00	14.70	1709	17020.5	19.320	1.2300	5317	607	•00046	2.915		5.769	1.515	283-4
40.00			:				1			204	11.194	1.632	305.3
100.00	00 و د		1555.2	19.320	1.2507	•5131 •4939	529 472	•0003·	3.805		18.624	1.703	318.5
400.00	1.50 .75	1070	1377.9	19.320	1.2766		416		4.215		31.071	1.764	329.6
450.50	•			i	1	1		i	4.800	352.8	61.164	1.825	341.4
1000.00	•30 •15		- 1286.6 1229.1	19.320 19.320	1.2950	: 4515 4361			5.284	358.4	101.998	1.864	348.6
2000 . 00	•06	630	: 118C.2	19.320	1.3212	4231		•0001	5.814		169.845	1.896	354.7
		•	i	k	0500		- 5.	927, 0/	-15.87	1 .	1	•	•
_				K = 2.00	PERC	T	T	T	1	т.		r	1
1.00		3103	2015.0	21.723	1.2068		710 706		0.000	388.2	2.172	0.000	34+6
1.00	250.00		1965.1	21.723	1.2071				. 554	246.3	1.262	• 390	66 • 6
1.40	214.29	2928	1923.2	21.723	1.2070	.5291			.757		1.062	•526 •618	
1.00	10/.20		1881.4	21.723	1.2100	.5271 .5295			1.000	213.4	1.000	.681	
1.70	150.00	2809	1650.4		1.2117		048	•0005	1.103	213.3	1.009	. 743	
4.00	75.00		1666.3	21.723	1.21/3		787	•0004	1.606	230•0	1.300	1.021	174.4
	30.00	2062	1478.1	21.723	1.2263	.4958	708	.0004	2.156	254.3	2.220	1.266	216.3
20.00	15.00		1370.1	21.723	1.2344	,4817	548	• 0003	1 2.541	269.8	3.519	1.403	
20.41	14.70	1804	1352.1	21.723	1.2347	.4813			2.553	270.2	3.569	1.406	
40.00	1.20	1565	1 124/09	21.723	1.2437	•4668	280		1	1			
100-00	3.00		1120.5	21.723		.4450					11.039	1.628	
400.00	1.00	11-1	1048.6	21.723	1.2706	.4295 .4x35			3.820 4.237		30.473	1.756	
400+03	• 75	902	701+4		1						-		
1000.00	.30	198	90741	21.123	1.3016	.3948			5.326		59.799 99.507	1.818	
2800±00 4000±00	.05		620.4	21.723	1.32/0	. 3712				329.6	165.365	1.887	
4000+00		_ ∴	-	1	1	i	4	4			L	1	1
								031, 0/			,		,
1.00	383.00	2723	. 1381.4	24.569	1.2103	0.4495	965	0.0004	0.000		2.179	0.000	30.4
1.00	285.71	2699	1370.5	24.669 24.669	1.2107	.4408	950 848	1 .000*	. 25	216.3	1.265	.391	58.5
1.40	203.00	2563 2563	1:09.6	24.659	1.2211	.4449	0.52	.0004	.754	192.7	1.054	.527	78.9
1.60	57.50	2501	1202.5	24.669	1.2222	.443i	921	-0.004	898	187.5	1.010		102.5
1.79	157.50 157.97 150.00	1 2402	1200.6	24.069	1.2231			. +0004:	1.09	187.0	1.008	.745	111.5
2 • 0 0 4 • 0 0	72.00	2112	1112.5	24.659	2310	4293		£000±	1.00	2: 201.3	1.293		152.9
				i		.4144	. 655	.0004	2.15	222.1	2.193	1.265	189.
10.00	10.00	1773	277-0	24.669 24.669	1.2913	4345	594	•0003	2.24	235.4		1.400	209 - 5
20.41	, 14.70	15.0	874.5	24.669 24.669	1.2505	•4021	570	0000	2.55	235.4 235.7 246.5	3.505	1.403	210 • 6 225 • 6
46.30	7.50	1000	796.4	24.669	1.2505	. 3698	236						
	3.00	1107	706.2	24.669	1.2/05		964	-0004	2 , 3 . 44	6 258.4	10.691	1.619	242.4
.00.00	1.50	950	648.9	24.669	1.2070		· ' +10	10001	3.85	265.7	17.627	1.687	252.
→90•9 0	• 1:	812	299.5	24.669	1.3000	: ۱۹۶۹ : :	360						-
	:	5. 604	1 545.5	24.065	1.0102	وفدوه أا	200	•0001	4.90	6 278.1	56.766		
1007-00			61.	1 36.860	1 1 - 3 5 1 2	• 5 6 5 7	/ 200	1000+	1 2.42	1 282.0	93.924	1.000	270 • (
1502.00 1000.00 4000.00	- 1 -	عداد د		24.005		.:	22.		عديد بداني	2 / 42 - 1	155.224	1.06	(14-1

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equivalence ratio, R; oxidant-fuel ratio, O/F.]

(g) Concluded. Combustion-chamber pressure, 500 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio, P _C /P	Static pressure, P, Ib/sqin.	Temp- erature, T, "K	Enthalpy, h,	Molecular weight, M	Isentropic exponent.	Specific heat, c _{p.}	Viscos- ity, µ, micro poises		M	Specific impulse in vacuum, I roc.	Area ratio,	. Thrust coefficient,	Specific impulse I,
		, ,	R	1 = 4.000	PERCE	INT FUEL	= 3•0	054, O/F	=31.74	6			L
1.00 1.05 1.20 1.40 1.60 1.79 2.00 4.00	300.00 285.71 250.00 214.29 187.50 167.18 150.00 75.00	2372 2351 2292 2226 2171 2123 2080 1817	1045.7 1022.3 996.0 973.8 955.2 938.0	26.307 26.307 26.307 26.307 26.307 26.307 26.307 26.307	1.2311 1.2315 1.2328 1.2343 1.2357 1.2369 1.2360 1.2456			0.00040 .00040 .00039 .00038 .00037 .00037 .00036	0.000 .282 .549 .750 .892 1.000 1.094	308.3 195.4	2.187 1.269 1.066 1.011 1.000 1.008	.392 .529 .621 .689	0 · 27 · 52 · 6 · 71 · 83 · 92 · 6 · 137 · 6 · 137 · 6 · 6 · 6 · 6 · 6 · 6 · 6 · 6 · 6 ·
10.00 20.00 20.41 40.00	30.00 15.00 14.70 7.50	1512 1309 1304 1129	647.4 645.3	26.307 26.307	1.2570 1.2669 1.2672 1.2777	.3694 .3585 .3582 .3476					3.393 3.439	1.396	170. 188. 188. 202.
100.00 200.00 400.00	3.00 1.50 .75	921 785 666	512.9 468.3 430.4	26.307 26.307 26.307	1.2932 1.3061 1.3193		411 362 316	.00015 .00013	3.890 4.338	231.0 237.3 242.4		1.675	217. 225. 233.
1000.00 2000.00 4000.00	.30 .15 .08	531 445 371	389.1 363.6 342.4	26.307 26.307	1.3369 1.3495 1.3589	.2917 .2860	261 224 190		6.117	247.8 251.1 253.8	53.783 88.429 145.294	1.819	240 • 245 • 248 •
		r : r			r	1		58, O/F) 		T	
1.00 1.05 1.20 1.40 1.60 2.00 4.00	300+00 285+71 250+00 214+29 187+50 165+43 150+00 75+00	2069 2050 1996 1936 1886 1841 1803 1566	855.0 847.7 828.0 806.0 787.4 771.2 757.5 672.6	27.313 27.313 27.313 27.313 27.313 27.313 27.313 27.313	1.2437 1.2442 1.2456 1.2473 1.2488 1.2514 1.2514	0.3713 .3707 .3690 .3670 .3652 .3636 .3622 .3530	742 737 724 710 697 686 677 614		•281 •246 •747 •888	282.4 178.9 159.2 154.5 153.6 154.1 165.3	2.194 1.272 1.068 1.012 1.000 1.007	.394 .531 .623 .694	0 • (25 •) 48 • 4 65 •) 76 •] 85 • 4 92 •)
10.00 20.00 20.41 40.00	30.00 15.00 14.70 7.50	1292 1112 1107 952	577.6 517.0 515.4 465.1	27.313 27.313 27.313 27.313	1.2721 1.2825 1.2829 1.2939	•3402 •3303 •3300 •3203	536 481 479 429	.00023 .00020 .00020 .00018	2.553 2.564	181.7 192.0 192.3 200.5	3.380	1.262 1.393 1.397 1.496	155.4 171.9 171.9
100.00 200.00 400.00	3.00 1.50 .75	770 651 548	407.9 372.1 341.9	27.313 27.313 27.313	1.3106 1.3239 1.3375	•3070 •2974 •2883	319 277	•00014 •00012 •00011	3.491 3.923 4.385	209.6 215.0 219.5	16.345 26.695	1.717	197.; 205.; 211.;
1000+00 2000+00 4000+00	• 30 • 15 • 08	433 361 299	309.3 289.4 272.8	27.313 27.313 27.313	1.3545 1.3639 1.3702		193	•00008 •00007 •00006	5.622 6.246	224.2 227.0 229.3	51.130 83.618 136.832	1.802	217.9 221.8 225.1

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIENED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OX GEN

(h) Combustion-chamber pressure, 600 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	Isentropic exponent,	Specific heat,	Viscos- ity, #,	Thermal conductivity,	Mach number M	Specific impulse in vacuum,	Area ratio,	Thrust coefficient, C _F	Specific impulse I,
P./P	llb/sqin. albs	°K	cal/g	201	γ	cal/(g)(°K)	poises	col/(sec)(°F (cm)	m	I _{vac} (lb)(sec)/lb	£		(b 1(sec)/(l
				= 0.150	PERCI	ENT FUEL	= 45.	65 · (/F	= 1.190)			
1	600.00	1183	5313.5	4.416	1.3396	1.7753	314	0+00073	0.000	T		0.000	0.
1.00	571.43	1168	5287.7	4.416	1.3406	1.7710	311	•00(73	•271	530-0	2.250	-210	47.
1.20	500.00	1129	5218.6	4.416 4.416	1.3436	1.7597	303 293	•00070 •00068	•527 •722	334.2 296.1	1.297	.403 .543	90 • 122 •
1.40	428.57 375.00	1049	5141.8	4.416	1.3497	1.7369	285	•00066	.860	286.6	1.018	•636	143.
1.87	321.68	1008	5006.8	4.416	1.3528	1.7257	276 272	•00063 •00062	1.000	284.4	1.000 1.003	•725 •761	163.
2.00	300.00 150.00	989 824	4975.4	4.416	1.3540	1.6825	234	•00052	1.566	301.7	1.233		232.
	60+00	643	4392.5	4.416	1.3748	1.6505	188	•00042	2.152	327.5	1.974	1.257	283.
20.00	30.00	532	4209.8	4.416	1.3799	1.6344	159	• 000 35	2.586	343.5	2.982	1.376	308.
40.00	15.00 14.70	439	4058.9	4.416	1.3824	1.6268	133	+00029	3.044	356.4	4.620	1.467	330 e
40.03	14.70	43,					1						
100.00	6.00	340 280	3899.0 3802.6	4.416	1.3082	1.5961	104	•00023 •00018		369.8	8.432 13.431	1.558	350.
400.00	3.00 1.50	230	3723.2	4.416	1.4068	1.5562	70	•00c15		384+1	21.488	1.652	
	•60	175	3640.1	4.416	1.4349	1.4847	55	•00(11	5.438	390.6	39.928	1.694	381.
2000.00	•30	142	3590.9	4.416	1.4550	1.4389	45	•00009	6.096	394.3	63.572	1.719	387.
4000+00	•15	114	3551.2	4.416	1.4705	1.4065	36	•00:07	6.845	397.3	100.938	1.739	391.
			F	R = 0.200	PERCI	ENT FUEL	= 38•	65, (/F	= 1.58	7			
1.00	600+00	1514	2969.7	5.216	1.3079	1-6183	402	0.00084	0.000		2 122	0+000	0.
1.05	571.43 500.00	1497	2941.7 2866.8	5.216 5.216	1.3090	1.6140	399	•00683 •00681	•274	552.2 348.6	2.233	•209 •400	94.
1.40	428.57	1398	2783.1	5.216	1.3155	1.5887	378	•00€78	•730	309.3	1.077	.539	127.
1.60	375=00 324•94	1354	2713.2	5.216 5.216	1.3185	1.5772	369 359	•00076 •00073	1.000	299.6 297.3	1.016		149.
2.00	300.00	1282	2601.1	5.216	1.3236	1.5584	353	•00C72	1.068	297.8	1.004	.757	179.
4.00	150.00	1079	2290.0	5.216	1.3391	1.5046	307	•00061	1.572	316.7	1.244	1.029	243•
10.00	60.00	852	1954.3	5.216	1.3558	1.4516	251	+00(48	2+148	344.7	2.009	1.257	297.
20.00 40.00	30 • 00 15 • 00	709 588	1748.8	5.216 5.216	1.3656	1.4232	213	+00(40 +00(34	2.573 3.010	362.0 376.0	3.049 4.739		325 ·
40.83	14.70	585	1573.4	5.216	1.3716	1.4062	178	•00(34	3.023	176.4	4.802	1.474	348.
100+00	6.00	458	1396.3	5.216	1.3771	1.3913	144	•00C26	3.619	190.5	8.679	1.565	370.
200.00	3.00	379	1286.2	5.216	1.3811	1.3807	117	•00(22	4.111	399.1	13.070	1.617	382.
400.00	1.50	312	1195.2	5.216	1.3861	1.3677	96	•00(18	4.638	406.1	22.296	1.662	392.
1000.00	•60	242	1099•0	5.216	1.3973	1.3400	74	•00(13	5.394	413.4	41.979		403.
2000.00	•30 •15	198 161	1041-1	5.216	1.4156	1.2977	61 50		6.704	417.7	67.687 108.754		
	1					ENT FUEL	- 33.		= 1.98		L	-	1
				6.016	1.2835	1.4955	481	0 • 0 0 (92	0.000	Τ	I	0.000	0.
1.00	600.00 571.43	1797	1249.3	6.016	1.2844	1.4917	477	•00(91	•276	563.4	2.219	. 207	50.
1.20	500.00 428.57	1745	1142.1	6.016	1.2870	1.4813	467 456	•00(89 •00(86	•538 •736	356.2	1.283	.398	96.
1.40		1636	961.5	6.016	1.2926	1.4591	446	•00(83	.876	306.6	1.015	•629	152.
1.83 2.00	327.79	1586 1555	909.9 864.0	6.016	1.2754	1.4485	436 429	+00(81	1.000		1.000	• 708 • 754	171.
4.00	150.00	1322	535.2		1.3125		378			325.5	1.256		249.
10.00	60.00	1057	176.3	6.016	1.3329	1.3225	314	+001 54	2.147	355.3	2.048	1.258	305.
10.00 20.00	30.00	887	9954.2	5.016	1.3401	1.2548	269	•00146	2.563	373.7	3.127	1.382	335.
40.00 40.83	15.00 14.70	740 736	9768.3	6.016	1.3569	1.2559	228	+00:38	3.000	388.6	4.883		359.
40.03	14.70	"30		1			ì						
100.00 200.00	6.00 3.00	580	9569.3	6.016	1.3663	1.2320	181	•001 30 •001 25	3.581	404.2	8.985		382. 395.
400.00	1.50	399	9347.6	6.016	1.3755		124			420.9	23.207	1.675	406
1000.00	•60	310	9240.9	6.016	1.3821	1.1948	95	+00(15	5.327	428.7	43.891	1.722	
2000.00	-30	256	9176.3	6.016	1.3885	1.1805	78	•00:12	5.945	453.4	71.275	1.749	424
4000.00	•15	210	9123.1	6.016	1.4039	1	54	•00:10	6.606	457.1	115.642	1.771	430.
				₹ = 0.30		ENT FUEL	= 29•	57. (/F	= 2.38	1		_	
1.00	600+00		9932.7		1.2647	1.3934	551 547	0.00197	0.000	>68.6	2.208	0=000 •206	50•
1.05 1.20	571.43	2073		6.815	1.2654		537		•278		1.278		97.
1.40	428.57	1951	9734.4	5.815	: 1.2701	1.3714	525	•00:91	.741	319.8	1.071	. 555	131.
1.60	375.00 330.09	1896	9659.5 9589.9	5.815 5.815	1.2724	1.3622	515 505		1.000		1.013		154. 172.
2.00	300.00	1807	9539.0	6.815	1.2764	1.3467	498	•00·85	1.082	309.0	1.006	.751	185.
4.00	150.00	1551	9200•2	6.815	1.2898	1.2980	444	•00, 74	1.585	330.4	1.266	1.025	252•
10.00		1256		6.815	1.3097		375		2 - 148	361.6	2.084	1.260	310.
20.00	30.00	1062 894	8592.4	6.815	1.3250	1.1548	325 278		2.555	381.0	3.205	1.387	341. 365.
40.83	14.70		8389.8	6.815	1.3309				2.901		>.104		
		706	8182.2	6.815	1.3532	1.1173	223	دد ٥٥٠	3.544	413.2	9,321	1.585	390.
100.00 200.00	6.00 3.00	589	8182.2	6.815	1.3605	1.1006	187	●00-27	4.014	423.0	14.986	1.643	404.
400.00	1.50	489	7943.1	6.815	1.3667		156		4.518	431.0	24.223	1.689	416.
1000.00	.60	382	7827.2	6.815	1.3725	1.0745	120	•00-17	5.248		45.976		
2000.00	•30	316	7756.9	6.815	1.3775	1.0640	98	•00:14	5.853	444.3	74.873	1.767	435.
	.15	261	7698.7	6.815	1.3029		80			448.4	122.117	1.790	440

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(h) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio,	Static pressure, P,	Temp- erature, T,	Enthalpy,	Molecular weight,	isentropic exponent,	Specific heat,	Viscos- ity, µ,	conductivity,	Mach number	Specific impulse in vacuum,	Area ratio,	Thrust coefficient	Specific impulse I,
P _c /P	Mo/sqin. oxbs	°K	cal/g	901	γ	cal/(g)(°K)*	micro poises	k, col/(sec)(°K)(cm)	M	I _{voc.} (No)(sec)/No	ε	C,	(b)(sec)/(l
			F	= 0.350	, PERCE	NT FUEL	= 26.	47, O/F	= 2.77	8			
1.00	600.00	2347	8892.8	7+610	1.2500	1.3056	611	0.00100	0.000			0.000	0 • 1
1.05	571.43	2324	8863.0	7.610	1.2507	1.3029	607	•00099	.280	569.9	2.199	•205	50 • 97 •
1.20 1.40	500.00 428.57	2263	8783.0 8693.3	7.610 7.610	1.2525	1.2955	597 585	+00097 +00094	•545 •745	360.8	1.274	.394 .532	131.
1.50	375.00	2135	8617.9	7.610	1.2565	1.2793	575	+00092	.886	311.5	1.012	.624	154.
1.81	331.93 300.00	2082	8550.7 8496.3	7.610 7.610	1.2582	1.2724	566 558	•00090 •00089	1.000	309.6	1.000	•696 •749	172.
2 • 00 4 • 00	150.00	1763	8152.6		1.2714	1.2233	504	•00078	1.590	332.7	1.274	1.024	253.
		1443	7774 4		1.2893	1.1638	432	•00064	2.150	365.0	2.116	1.261	312.
20.00	60.00 30.00	1231	7770.0 7528.4	7.610	1.3043	1.1192	379	+00055	2.551	385.2	3.276	1.390	344.
40.00	15.00	1044	7322.8	7.610	1.3196	1.0783	328	•00046	2.954	401-7	5.180	1.491	369.
40.83	14.70	1039	7317.2	7.610	1.3200	1.0772	326	-00046	2.966	402-1	5.252	1.494	370•
100.00	6.00	832	7099•0	7.610	1.3371	1.0358	266	•00036	3.513	419.0	9.659	1.594	395.
200 • 00 400 • 00	3.00 1.50	697 ·	6960.9 6845.4	7.610 7.610	1.3480	1.0115	224 187	•00030	3.967 4.457	429.3 437.8	15.596 25.296	1.654	410.
400.00	1.00	302	004364	1.010		•,,,,,		10000					
1000.00	•60	457	6721.6	7.610	1.3638	•9790	147	•00019	5.166	446.6	48.178 78.663	1.754	434.
2000.00 4000.00	•30 •15	379 314	6646.1 6583.5	7.610 7.610	1.3688	•9693 •9597	120 97	•00016 •00013	6.399	456.2	128.622	1.809	448.
						L							
				= 0.400		NT FUEL			= 3 - 179				,
1.00	571.43	2574 i 255n	8050•5 8020•9	8.396 8.396	1.2385	1.2292	663 659	0.00101 -00100	0.000 -281	568.3	2.191	0.000 205	50.
1.20	500.00	2485	7941.4	8.396	1.2405	1.2210	649	•00098	.547	360.0	1.271	.393	97.
1.40	428.57	2412	7852.0	8.396 8.396	1.2423	1.2137	638	•00096 •00094	•748 •890	4-20ء 11ءاد	1.067	•530 •622	131.
1.60	375.00 333.35	2350	7776.8 7712.1	8.396	1.2454	1.2012	627 618	•00093	1.000	309.4	1.000	•692	171.
2.00	300.00	2249	7655.4	8.396	1.2468	1.1958	610	•00091	1.091	310-3	1.007	• 748	185.
4.00	150.00	1956	7310.9	8.396	1.2566	1.1592	557	•00081	1.595	333.1	1.281	1.023	253.
10.00	60.00	1615	6924.5	8.396	1.2724	1.1057	484	•00068	2.152	366.2	2.143	1.262	313.
20.00 40.00	30.00 15.00	1388	6678.4 6467.6	8.396 8.396	1.2863	1.0634	429 375	•00058 •00049	2.548	386.9 404.0	3.338 5.310	1.393	345.
40.83	14.70	1181	6461.8	8.396	1.3018	1.0211	374	•00049	2.955	404.5	5.384	1.499	371.
		25.	(224)	0.20/	1 7 6	.9745	308		3.487	422.1	9.975	1.602	397.
100.00 200.00	6 • 00 3 • 00	954 804	6236.1 6092.2	8.396	1.3208	.9460	261	•00039 •00032	3.927	432.9	16.185	1.665	412.
400.00	1.50	675	5971.1	8.396	1.3443	.9241	220	•00027	4.401	441.7	26.355	1.715	425
1000.00	•6g	532	5840.7	8.396	1.35>1	.9033	173	+00021	5.088	451.0	50.405	1.768	438.
2000.00	•30	443	5760.9	8.396	1.3607	-8928	143	•00017	5+663	456.6	82.493	1.800	446.
4000•00	•15	369	5694.5	8.396	1.3661	.8833	117	•00014	6.288	461.2	135.208	1.826	452.8
			F	= 0.450	• PERCE	NT FUEL	= 21•6	7, 0/F	= 3.571	L			
1.00	600.00	2773	7354.5	9.167	1.2292	1.1624	707	0.00101	0.000			0.000	0•
1.05	571.43	. 2748	7325.3 7246.7	9.167 9.167	1.2297	1.1604	704 694	•00101 •00099	•282 •549	564.6 357.9	2.186 1.268	•204 •392	50 • 96 •
1.40	500.00 428.57	2680	7158.4	9.167	1.2326	1.1487	682	•00097	.751	318.6	1.066	.529	130.
1.60	375.00	2539	7084.0	9.167	1.2339	1.1433	672	•00095	.893	309.5	1.011	.621	153.
1.79 2.00	334.56 300.00	2484	7021.9 6963.8	9.167	1.2352	1.1386	663 655	•00094 •00092	1.000	307.8	1.000 1.008	.746	184
4.00	150.00	2127	6621.6	9.167	1.2420	1.1016	602	•00083	1.598	332.0	1.286	1.022	252•
10.00	40.00	1769	6235.4	9.167	1.2589	1.0541	529	•00070	2.153	365.5	2.165	1.263	312.
10.00	60.00 30.00	1530	5987.8	9.167	1.2713	1.0157	474	•00061	2.546	386.7	3.389	1.396	344.
40.00	15.00	1316	5774.3 5768.5	9.167 9.167	1.2855	•9761 •9750	415	•00052 •00052	2.936	404.3 404.7	5.420	1.501	370 • 371 •
40.83	14.70	1310	2/00.5	7.107	1.2009	•,,,,,	711	*00072	2.0.41		,,,,,	24,0	
100.00	6.00	1068	5538.2	9.167	1.3053	•9267	348 298	+00042	3.467 3.895	422.9 434.1	10.256	1.674	397.
200.00 400.00	3.00 1.50	905 763	5390.3 5265.1	9.167	1.3195	.8952 .8693	252	•00035 •00029	4.353	443.3	27.347	1.726	426.
										(53.5		1 701	440
1000.00 2000.00	•60 •30	605 506	5129.7 5046.4	9.167	1.3452	.8448 .8303	199 165	•00022 •00018	5.021	453.0 458.8	52.536 86.213	1.781	440 • 1
4000.00	•15	422	4976.9	9.167	1.3589	.8207	136	•00015	6.187	463.6	141.612	1.841	454-1
		L	R	= 0.500	• PERCE	NT FUEL	= 20+1	2, 0/F	= 3.968	l			
1.00	600.00	2944	6769.6		1.2218	1.1037	,	0.00101	0.000			0.000	0.0
1.05	571.43	2918	6741.0	9.919	1.2222	1.1020	741	•00100	.283	559.4	2.181	.204	49.
1.20	500.00 428.57	2848 2769	6663.8 6577.1	9.919 9.919	1.2234	1.0971	731	•00099 •00097	•551 •753	354.7 315.9	1.266	.391 .528	95.
1.40	375.00	2702	6503.9	9.919	1.2261	1.0865	710	•00095	.895	306.9	1.011	•620	152.
1.79	335.48	2647	6444.3	9.919	1.2272	1.0823	701 693	+00093 +00092	1.000	305 • 4 306 • 4	1.000	•686 •745	168.
2.00 4.00	300.00 150.00	2592 2275	6385.6	9.919 9.919	1.2282	1.0781	640	•00092	1.601	329.7		1.022	250.
						1							
10.00 20.00	60 • 00 30 • 00	1904 1655	5665.2 5418.4	9.919 9.919	1.2480	1.0081	568 513	•00072 •00063	2.154	363.5 385.0	2.183 3.431	1.398	310.
40.00	15.00	1431	5204.5	9.919	1.2724	.9359	457	•00354	2.930	402.8	5.512	1.505	369.
40.83	14.70	1424	5198.6	9.919	1.2728	.9348	455	•00u54	2.941	403.3	5.591	1.508	369•
100.00	6.00	1170	496624	9.919	1.2916	.8875	د ه د	+00044	3.452	421.9	10.495	1.615	396.
200.00	3.00	997	4816.2	9.919	1.3065	-8539	331	•00037	3.869	433.4	17.193	1.681	414.
	1.50	845	4688.5	9.919	1.3202	-8260	282	•00030	4.315	442.9	28.235	1.735	425.
400.00			İ	1		ł			4.962	452.9	54.491	1 202	439.
400.00	•60	674	4549.6		1.3357	.7971	225	•00024				1.792	
	•60 •30 •15		4549.6 4463.8 4391.9	9.919	1.3357 1.3449 1.3524	.7971 .7812	187 155	•00024 •00019 •00016	5.204	458.9 463.9	89.675 147.626	1.827	447.

TABLE II. - Continued. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID CXYGEN

(h) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute; frozen composition during isentropic expansion

ratio,	Static pressure, P, lb/sg.in	Τ,	Enthalpy, h,	Molecular	Isentropic exponent,	Specific heat, c _{p.}	Viscos- ity, μ,	Thermal conducti ity, k,	Mach number	Specific impulse in vacuum, I	Area ratio,	. Thrust coefficient, C ₄	
P _c /P	lb/sqın orbs	K	col/g	M	γ	cal/rg/(1K)	poises	k, cal/(sec)∈≯ (cm)	m	vac :lb:rsect/6b	ε	· -,	don secu/
			i	} ≃ 0•60(PERCE	NT FUEL	= 17•	35. C/F	= 4.76	2			
1.00	630-00	3208	5841.6	11.347	1.2112	1.0044	 803	0.00038	0.000			0.000	0.
1.05	571.43	3180	2014.3	11.347	1.2112	1.0031	400	• 00()6	.284	1 246.0	2.175	• 203	48+
1.40	500.00	3107	5740.5	11.347	1.2125	.9994 .9950		•00096 •00094	•255 •756	346.4	1.263		
1.60				11.347		.9910		•00074	.898	200.0		• 917	148.
1.78	336.01	. 2898	2233.1	11.347	1.2100	•9d//	160	*00C *4					105.
2.00 4.00	300.00 1:0.00	2506	5150.9	11.347 11.347	1.2165	.9841 .9516		0+30C+0				1.021	1/8. 245.
10.00	60.00	2115	4780.9	11-147	1.2328	.9274	629	•00C72	2.156	ט•סלג !	2.209	1.260	303.
20.00		1851	4540.5	11.347	1.2422	.5902	5/4	•00C >4	2.042	270.4	3.492	1.401	336.
40.00 40.83		1613	4330.4	11.347 11.347	1.2532	.8665 8555	51d	•00036	2.922	396.5 397.0	5 - 648	1.510	302.
100.00	6.00 3.00	1334	4094.4	11.347	1.2702	.8224 .7890	443 387	•000 •6	3.43L	410.0	10.859	1.624	905.
400.00	1.50	981		11.347		.7270	394	•00033	4.260	431.1	24.604	1.749	417.
1000.00.	• 60	790	3673.4	11.347	1.3101	.7496	470	•00042	4.8/6	440.4	57.726	1.009	454.
2000-00	•30	667	3585.1	11.347	1.3299	•7226 •7060	227	·000 ±1	5.391	454.6	A2.210	1.645	443.
4000.00	• 15	560	. 351ۥ8	11•347	1.3397	•6405	169	•00C11	5.755	459.5	57.726 95.510 157.952	1.010	450•
			ŀ	= 0.700), PEKCE	NT FUEL	= 15 • 2	25. U/F	= 5.55	b			
1.00	600.00	3381	5138.3	12.664	1.2044	0.9246	846	0.00075	0.000			0.000	
	571.43	3353	5112.5	12.664	1.2047	.9234	842	•00€₹4 •00€₹3	.285	230.7	2.171 1.262	• 203 • 369	41. 91.
1.2c	428.57	3192			1.2006	.9164	920	•00C +1	150	300.6	1.062	• 525	122.
1.60	375.0C	3120	4595.7	12.554	1.2006	.9106	810	•00C+0	• 700	241.4	1.009		
1.78 2.00	337.67 300.00	3004 300Z	4791.5	12.664	1.2002	.91g6			1.100	291.7	1.000		173.
4.00				12.064	1.2146	•8892				314+1			£ 35 •
10.00	60.00	2251	4131.1	12.564	1.2233	•#295	0/2	•000/1	2.157	340.1		1.200	290.
20 • BC	30.00	1985	390001	12.554	1.2314	.5349 .5071	61/ 160	•000 >4	2.241	367.4 307.5	3.332	1.404	320 • 354 •
40.00 40.83	15.00	1732	3692.8		1.2415			•00C>6	2.921	301.0		1.517	
					1 1000	.7679	486	005.7			11 100	1.630	381
100.00°	5.00 3.00	1448	3323.0	12.664	1.2700	.7372	429	•00C+0	3.410	40/•0 419•0	18.418		
400.00	1.50	1078	3196.4	12.664	1.285i	•10/3	373	• 00C 34	4.226	429.0	30.635	1.755	4114
1000.00	•60	875	3056.3	12.664	1.3043	.6726	د و د	•00c : 7	4.822	439.7	60.039	1.820	420.
2000.00	•30	. 742	2968.5	12.664	1.31/7	• b > 0 c	458	•000 ±2	5.317	446.2	60.039 99.783 165.647	1.855	4 34.
4000•00 -	•15	627	2894.2	. 12.004	1+3291	•6337	211	•00010	⊃•00€	. 452.0	100.041	: 1.070	7711
				2 - 0.800	PERCE	NT FUEL	= 13•6	50 • C/F	= 6.34	9			
1.00	600.00	3481	4586.9	13.859	1+2004	0.8591	675	0.0001	0.000			0.000	
1.05	571.43	3453	4562.6	13.559	1.2005	•8560		• 000 10		514.8 326.8	Z.168 I.260		
1.20	500.00 426.57				1.2024	.8019	549	• 0 0 C 1 B	. /59	c91.4	1.062	⊃∠5	119.
1.60	375.00	3217	4261.3	13.859	1.2032	•8490	839	•000 16	•90z	600.5	1.009		140.
1.77		3161	4314.0 4260.3	13.859	1.2039	.8466	831	+000 15 +000 14	1.100	202.i 283.2	1.000		168.
	300 00	300#		13.050	1.2097	8273		* DOC 2 .	1.608	305.1	1.304		
2.0C	300.00 150.00	2020	3969.9	13.359	1020	•0213	170	• 0 0 C 7 8			10004	1.040	2310
2.00 4.00	150.00	2750	3969.9				1			338.4			
2.00	150.00 60.00 30.00	2750 2341 2065	3969.9 3636.1 3417.4	13.859 13.859	1.2177	. +8024 .7803	700	•000×9 •000×4	2.157	33 6.4 359 .4	2•236 3•556	1.267	287. 319.
2.00 4.00 10.00 20.00 40.00	150.00 60.00 30.00 15.00	2750 2750 2341 2065 1814	3969.9 3636.1 3417.4 3224.8	13.859 13.859 13.859	1.2177	. 8024 .7603 .7557	700 646 250	•000 >9 •000 >2 •000 >2	2.157 2.940 2.913	359.4 211.1	2.236 3.556 5.791	1.267 1.405 1.510	287. 319. 344.
2.00 4.00 10.00 20.00	150.00 60.00 30.00 15.00	2750 2750 2341 2065 1814	3969.9 3636.1 3417.4	13.859 13.859	1.2177 1.2254 1.2342	. 8024 .7603 .7557	700 646 250	•000 >9 •000 >2 •000 >> •000 >>	2.157 2.540 2.713 2.724	359.4 311.1 311.0	2.236 3.556 5.791 5.670	1.267 1.405 1.510 1.519	287. 319. 344.
2.00 4.00 10.00 20.00 40.00 40.00	50.00 150.00 60.00 30.00 15.00 14.70	2750 2750 2341 2065 1814 1807	3969.9 3636.1 3417.4 3224.8 3219.2	13.859 13.859 13.059 13.059	1.2177 1.2251 1.2342 1.2345	.8022 .7603 .7557 .7549	700 646 550 568 514	.000 >9 .000 >2 .000 >2 .000 >2	2.157 2.940 2.913 2.924 3.410	359.4 311.1 311.0	2.236 3.556 5.791 5.676	1.267 1.405 1.510 1.519	287. 319. 344. 344.
2.00 4.00 10.00 20.00 40.00 40.00	60.00 30.00 15.00 15.00	2750 2750 2341 2065 1814 1807	3969.9 3636.1 3417.4 3224.8 3219.3	13.859 13.859 13.059 13.059	1.2177 1.2251 1.2342 1.2345 1.2345	.8022 .7603 .7557 .7549	700 646 550 568 514	.000 >9 .000 >2 .000 >2 .000 >2	2.157 2.540 2.913 2.924 3.410 3.799	359.4 311.1 311.0	2.236 3.556 5.791 5.576	1.267 1.405 1.516 1.519 1.633 1.704	287. 319. 344. 344. 370.
2.00 4.90 10.00 20.00 40.00 40.00 20.00 200.00 40.00	150.00 60.00 30.00 19.00 14.70 6.00 2.00 14.70	2750 2750 2341 2065 1814 1807 1518 1319	3969.9 3636.1 3417.4 3224.8 3219.3 3000.4 2803.5 2743.0	15.859 13.859 13.059 13.059 13.059 13.059	1.2177 1.2251 1.2342 1.2345 1.2465 1.2565 1.2656	.8022 .7803 .7007 .7049 .7249 .7203 .6936	700 646 570 566 514 457 404	.000 >9 .000 >2 .000 >> .000 >> .000 +6 .000 +6 .000 34	2.157 2.940 2.913 2.924 3.410 3.799 4.207	359.4 377.1 377.0 396.4 400.3	2.236 3.556 5.791 5.670 11.247 10.724 31.251	1.267 1.405 1.516 1.519 1.633 1.704 1.764	287. 319. 344. 344. 370. 387. 400.
2.00 4.00 13.00 20.00 40.00 40.00 100.00 200.00 400.00	150.00 150.00 60.00 30.00 15.00 14.70 6.00 2.00 1.50	2750 2750 2341 2065 1814 1807 1518 1319 1139	3969.9 3636.1 3417.4 3224.8 3219.0 3000.4 2809.5 2749.0 2008.0	13.859 13.859 13.859 13.859 13.859 13.859	1.2177 1.2271 1.2294 1.2342 1.2345 1.2495 1.2610 1.2610 1.2796	.8022 .7803 .7997 .7949 .7249 .7293 .6930	700 646 550 568 514 457 401 530 284	.000 >9 .000 >2 .000 >> .000 >> .000 +6 .000 +0 .000 14	2.157 2.940 2.913 2.924 3.410 3.799 4.207	359.4 377.1 377.6 396.4 400.3 410.2	2.236 3.556 5.791 5.670 11.247 10.724 31.251	1.267 1.405 1.519 1.519 1.635 1.704 1.764	287. 319. 344. 344. 370. 387. 400.
2.00 4.00 13.00 23.00 40.00 40.00 100.00 200.00 400.00 2003.00 4000.00	300.00 150.00 60.00 30.00 15.00 14.70 5.00 3.00 1.50	2750 2750 2341 2065 1814 1807 1518 1319 1139	3969.9 3636.1 3417.4 3224.8 3219.0 3000.4 2809.5 2749.0 2008.0	15.859 13.859 13.059 13.059 13.059 13.059	1.2177 1.2271 1.2294 1.2342 1.2345 1.2495 1.2610 1.2610 1.2796	.8022 .7803 .7007 .7049 .7249 .7203 .6936	700 646 570 566 514 457 404 530 284	.000 >9 .000 >2 .000 >2 .000 >2 .000 >2 .000 >2 .000 >4 .000 >4 .000 >2	2.157 2.940 2.913 2.924 3.410 3.799 4.207	359.4 377.1 377.6 396.4 400.3 410.2	2.236 3.556 5.791 5.670 11.247 10.724 31.251	1.267 1.405 1.519 1.519 1.635 1.704 1.764	287. 319. 344. 344. 370. 387. 400.
2.00 4.00 13.00 20.00 40.00 100.00 200.00 400.00 200.00 400.00	300.00 150.00 60.00 30.00 15.00 14.70 5.00 3.00 1.50	2750 2750 2341 2065 1814 1807 1518 1319 1139	3969.9 3636.1 3417.4 3224.8 3219.0 3000.4 2809.5 2749.0 2008.0	13.859 13.859 13.059 13.059 13.059 13.059 13.059 13.059 13.059	1.2177 1.2251 1.2342 1.2345 1.2450 1.2615 1.2615 1.2756 1.2951 1.3091 1.3216	.8022 .7003 .7004 .7049 .7049 .7009 .6916 .6630	700 646 550 568 514 457 401 530 281 237	.000 >9 .000 >2 .000 >2 .000 >2 .000 >2 .000 +6 .000 +6 .000 +6 .000 +7 .000 +2 .000 +2 .000 +2	2.157 2.940 2.913 2.924 3.410 3.799 4.207	359.4 377.1 377.6 376.4 406.3 416.2 426.9 430.9 440.9	2.236 3.556 5.791 5.670 11.247 10.724 31.251	1.267 1.405 1.519 1.519 1.635 1.704 1.764	287. 319. 344. 344. 370. 387. 400.
2.00 4.00 13.00 20.00 40.03 100.00 200.00 400.00	500.00 150.00 30.00 10.00 14.70 6.00 3.00 1.50 .60 .15	2750 2341 2065 1814 1807 1518 1319 1139 791 670	3969.9 3636.1 3417.4 3224.8 3219.0 3006.4 2809.5 2740.0 2008.0 2008.0 2450.2	13.859 13.859 13.059 13.059 13.059 13.059 13.059 13.059	1.2177 1.2251 1.2342 1.2345 1.2455 1.2615 1.2615 1.2756 1.2756 1.2951 1.3091 1.3216	.8022 .7803 .7997 .7949 .7249 .64916 .6530 .6294 .6073 .5393	700 646 990 988 914 457 402 251 251 237	.000 >9 .000 >2 .000 >2 .000 >2 .000 >2 .000 +6 .000 +6 .000 +6 .000 +7 .000 +2 .000 +2 .000 +2	2.157 2.940 2.413 2.424 3.410 3.794 4.207 4.184 2.272 5.801 = 7.14	359.4 377.0 370.6 390.6 400.3 410.2 420.9 430.9 440.9	2.236 3.556 5.791 5.676 11.247 16.724 31.251 61.524 102.579 170.764	1.267 1.405 1.519 1.519 1.635 1.704 1.764	287. 319. 344. 344. 370. 387. 400. 415. 423.
2.00 4.00 13.00 23.00 40.00 40.03 100.00 200.00 200.00 200.00 200.00 200.00	500.00 60.00 30.00 1	2750 2341 2065 1814 1807 1518 1319 1139 929 791 670	3969.9 3636.1 3417.4 3224.8 3219.9 3000.4 2809.5 2749.0 2522.7 2450.2	13.859 13.859 13.059 13.059 13.059 13.059 13.059 13.059 13.059 13.059 13.059	1.2177 1.2251 1.2342 1.2345 1.2455 1.2455 1.2455 1.2455 1.2455 1.3091 1.3216 0. PERCE	.8022 .7803 .7907 .7949 .7249 .7249 .7259 .8030 .8030 .8030	700 046 050 050 050 050 050 050 050 050 050 05	.00C >9 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >3 .00C >4 .00C >	2.157 2.940 2.943 2.924 3.410 3.799 4.207 4.189 2.272 5.801 = 7.14	359.4 377.0 376.4 408.3 410.2 420.9 430.0 440.9	2.236 3.556 5.791 5.676 11.247 16.724 31.251 61.524 102.579 170.764	1.267 1.405 1.519 1.519 1.633 1.704 1.764 1.866 1.899	287. 319. 344. 344. 370. 387. 400. 415. 423.
2.00 4.00 13.00 20.00 40.00 40.00 200.00 40.00 200.00 400.00 200.00 400.00	500-00 50-00 30-00 10-00 14-70 6-00 2-00 1-20 -500-00 571-42 500-00	2750 2341 2065 1814 1807 1518 1319 1139 929 791 670	3969.9 3636.1 3417.4 3224.8 3219.9 4009.5 2749.6 2509.0 2522.7 2450.2	13.859 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659	1.2177 1.2251 1.2342 1.2342 1.2345 1.2455 1.2456 1.2951 1.3091 1.3216 0. PERCE	.8022 .7603 .7507 .7549 .6294 .6530 .6294 .6530 .6294 .6075 .5323 .NT FUEL	700 046 050 000 000 014 457 401 030 281 237 = 12.3	.00C >9 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >3 .00C >4 .00C >2 .00C >3 .00C >	2.157 2.940 2.913 2.924 3.410 3.799 4.207 4.789 5.801 = 7.14 0.000 2.860 1000 2.700	359.4 377.6 376.6 400.2 420.9 440.9 497.2 411.0	2.236 3.556 5.791 5.676 11.247 16.724 31.251 61.524 102.579 170.764	1.267 1.405 1.510 1.519 1.633 1.704 1.764 1.827 1.8899	287. 319. 344. 370. 387. 400. 415. 423. 431.
2.00 4.00 10.00 20.00 40.00 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	500-00 150-30 62-80 30-90 19-3	2750 2341 2065 1814 1807 1518 1319 1139 791 670 3526 3492 3421 3321	3969.9 3636.1 3417.4 3224.8 3219.0 3006.4 2600.0 2740.0 2222.7 2450.2 4120.1 4000.7 3101.4 3790.8	13.859 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659	1.2177 1.2251 1.2362 1.2363 1.2653 1.2653 1.2750 1.2750 1.3216 0. PERCE 1.1982 1.1992 1.1992 1.1994 1.2004	. d024 .7004 .7004 .7004 .6203 .6004 .6004 .6004 .6004 .6003 .7003 .7003 .7003	700 046 050 000 000 014 457 401 251 251 251 252 081 059	.00C >9 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >2 .00C >37 .00C >	2.157 2.540 2.913 2.924 3.410 3.729 4.207 4.1872 5.801 = 7.14 0.000 2.286 5.200 1.752	359.4 371.1 371.0 370.4 400.2 410.2 420.9 430.9 440.9 311.0 202.0 214.0	2.236 3.556 5.791 10.6724 10.724 10.2575 170.764	1.267 1.405 1.510 1.519 1.704 1.764 1.866 1.8899	287. 319. 344. 344. 344. 400. 415. 423. 431.
2.00 40.00 10.00 20.00 40.00 40.00 200.00 200.00 200.00 200.00 400.00 10	500-00 150-00 10-00	2750 2341 2041 2061 1814 1807 1518 1319 1139 929 791 670 3526 3498 3491 3201 3201	3969.9 3636.1 3417.4 3249.8 3219.9 3000.4 2000.5 2749.0 2522.7 2450.2 4142.9 4120.1 4000.7 3000.4 3000.8 3000.8 4142.9	13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 14.930 14.930 14.930 14.930 14.930 14.930	1.2177 1.2251 1.2362 1.2460 1.2600 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010	. d024 .7807 .7244 .6872 .6872 .6872 .6872 .7873 .7781 .7781 .7781	700 046 070 060 14 457 401 237 237 237 241 261 261 652 653 654 654	000 39 000 12 000 13 00	2.157 2.540 2.713 2.724 3.410 3.727 4.207 2.272 5.801 = 7.14 0.000 2.250 1.750 1.750 1.750 1.700	359.4 371.1 371.0 370.4 400.3 410.2 420.9 430.5 440.9 33 497.2 411.0 424.0 440.5	2.236 3.556 5.791 5.876 11.247 10.724 31.251 61.524 102.575 170.764	1.267 1.405 1.510 1.519 1.633 1.764 1.764 1.866 1.899	287. 319. 344. 376. 387. 400. 415. 423. 431.
2.00 4.00 13.00 20.00 40.00 20.00 200.00 200.00 400.00 1.00 1.00	500-00 150-00 10-00	2750 2341 2041 2061 1814 1807 1518 1319 1139 929 791 670 3526 3498 3491 3201 3201	3969.9 3636.1 3417.4 3249.8 3219.9 3000.4 2000.5 2749.0 2522.7 2450.2 4142.9 4120.1 4000.7 3000.4 3000.8 3000.8 4142.9	13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 14.930 14.930 14.930 14.930 14.930 14.930	1.2177 1.2251 1.2362 1.2460 1.2600 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010 1.2010	. d024 .7004 .7004 .7004 .6203 .6004 .6004 .6004 .6004 .6003 .7003 .7003 .7003	700 646 570 700 714 457 401 730 281 237 896 896 687 687 687 687 687	.000 >9 .000 >2 .000 >2 .000 >0 .000 >0 .000 *0 .000 *0 .000 *1 .000 *2 .000 *2 .000 *3 .000 *3 .000 *4 .000 *3 .000 *4 .000 *3 .000 *4 .000 *	2.157 2.54C 2.743 2.724 3.410 3.777 4.207 4.187 5.801 = 7.14 0.000 2.86 0.177 9.72 1.000 1.100	359.4 371.1 371.0 370.4 400.2 410.2 420.9 430.9 440.9 311.0 202.0 214.0	2.236 3.556 3.556 3.791 11.247 10.724 31.231 61.524 102.575 170.764	1.267 1.405 1.510 1.519 1.633 1.764 1.764 1.866 1.899	287. 319. 344. 344. 344. 347. 400. 415. 423. 431.
2.00 10.00 20.00 40.00 40.00 20.00 200.00 40.00 1000.00 2000.00 1000.00 1.00 1.00 1	500-00 50-00 1	3526 341 2055 1814 1807 1518 1319 1139 1139 141 570 3526 3421 1504 5205 3141 2792	3969.9 3636.1 3417.4 3224.8 3219.0 3000.4 2600.0 2749.0 2722.7 2450.2 4120.1 4120.1 4379.0 379.0 379.0 379.0 379.0 379.0 379.0 379.0 379.0 379.0 379.0	13.859 13.859 13.659 13	1.2177 1.2251 1.7342 1.2345 1.2455 1.2755 1.2755 1.3051 1.3051 1.3255 PERCE 1.1345 1.1345 1.1345 1.1345 1.1452 1.1452 1.1452 1.1452 1.1453 1.1452 1.1453 1.1	#8024 7603 1797 1/203 5/204 5/204 5/204 5/204 5/204 5/204 5/204 6/20	700 646 590 500 514 457 401 281 281 281 281 896 892 689 689 689 689 689 689 689 689 689 689	.000 >9 .000 >2 .000 >2 .000 >2 .000 >2 .000 >0 .000 *6 .000 *6 .000 *6 .000 *7 .000 *2 .000 \$7 .000 \$	2.157 2.540 2.743 2.744 3.410 3.757 4.187 9.272 5.801 = 7.14 0.000 2.266 3.757 9.272 5.801 1.757 9.272 1.757	359.4 371.1 374.0 370.0 400.3 410.2 420.9 430.9 440.9 311.0 202.0 214.0 214.0 214.0 214.0 214.0 214.0	2.236 3.556 3.556 7.791 7.507 11.247 10.724 10.257 170.764 2.167 1.000 1.000 1.010 1.30c	1.267 1.405 1.510 1.510 1.704 1.704 1.862 1.8899 0.000 202 309 202 0.202 0.202 0.202 0.202 0.202 0.202	287. 319. 344. 376. 387. 400. 415. 423. 431. 60. 444. 60. 447. 149. 149. 169.
2.00 4.00 13.00 20.00 40.00 40.00 100.00 200.00 4.00 1000.00 1.00 1.00 1.00 1.00 1	500-00 14-70 6-00 14-70 6-00 14-70 6-00 15	2750 2750 2750 2750 2341 2005 814 1807 1519 1139 929 791 670 3526 3421 2005 3141 2792 2381	3969.9 3636.1 3417.4 324.8 3219.9 3000.4 2609.0 2749.0 4142.9 4142.1 4190.1 4190.1 3790.8 3839.7 3562.3 3647.3	13.859 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 13.659 14.730 14.730 14.730 14.730 14.730 14.730	1.2177 1.2251 1.2345 1.2345 1.2455 1.2555	. d024 .7003 .7004 .7004 .7004 .7004 .8007 .8007 .8009 .8009 .8009 .8009 .8009 .7009	700 046 070 080 014 401 251 237 = 12.52 896 896 905 905 905 905 905 905 905 905 905 905	.000 >9 .000 >2 .000 >2 .000 >0 .000 >0 .000 *0 .000 *0 .000 *1 .000 *2 .000 *2 .000 *3 .000 *3 .000 *4 .000 *3 .000 *4 .000 *3 .000 *4 .000 *	2.157 2.540 2.724 3.410 3.747 4.207 4.727 5.801 = 7.14 0.000 2.266 2.50 1.757 7.72 1.000 1.100 1.100 1.1000	359.4 371.1 370.5 400.5 410.2 420.9 430.9 440.9 311.6 202.0 214.0 214.0 274.0 249.0	2.236 3.556 3.556 2.791 3.201 61.224 102.575 170.764 2.167 1.200 1.200 1.201 1.202	1.267 1.405 1.510 1.510 1.519 1.633 1.704 1.866 1.899 0.000 202 202 202 201 204 204 204 204 204 204 204 204 204 204	287. 319. 344. 370. 387. 400. 415. 423. 431.
2.00 40.00 40.00 40.00 40.00 200.00 200.00 200.00 200.00 200.00 1.00 1	500-00 14-70 6-00 14-70 6-00 14-70 6-00 14-70 6-00 14-70 14-	2750 2750 2750 2750 2341 2005 1814 1807 1518 1137 929 1670 3526 3498 3498 3491 3201 3201 3201 2792 2381 2105 1851	3969.9 3636.1 3417.4 32448 3219.9 3036.4 2690.5 2743.6 2050.7 4142.7 4122.7 4120.1 4190.7 4190.7 3191.4 3258.6 3250.7 33040.7 2658.5	13.859 13.859 13.659 13	1.2177 1.2251 1.2349 1.2499 1.2499 1.2799 1.2799 1.3091 1.3256 PERCE 1.1982 1.1994 1.2001 1.2001 1.2002 1.2001 1.2002 1.2002 1.2002 1.2003	. 4024 7-603 7-7-44 7-7-44 7-7-44 7-7-45 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15 8-7-7-15	700 646 570 700 700 700 700 700 700 700 700 700	-00(5) -00(5)	2.157 2.740 2.742 3.410 4.207 4.187 9.202 4.187 9.202 4.187 9.202 4.102 4.102 4.102 4.102 4.102 4.102 4.102 4.102 4.103 4.203	399.4 37(-1) 37(-1) 37(-1) 370.2 400.3 410.2 420.2 430.2 440.2 31(-1) 201.2 21(-1)	2.236 3.556 2.791 2.676 11.247 16.724 31.231 61.524 102.575 170.764 2.167 1.001 1.001 1.001 1.001 1.000 1.010 1.010	1.267 1.405 1.510 1.510 1.633 1.704 1.764 1.866 1.899 0.000 202 202 201 1.616 7.742 1.023 1.267 1.406 1.517	287. 319. 344. 340. 301. 400. 415. 423. 431. 60. 115. 115. 125. 24. 27. 27. 27.
2.00 10.00 20.00 40.00 40.00 40.00 200.00 200.00 200.00 100.00 200.00 1.0	500-00 150-00 150-00 150-00 150-00 14-70 6-00 1-50 -50 -50 -50 -50 -50 -50 -50 -50 -50	2750 2341 2065 1814 1807 1518 1319 1139 929 1670 3526 3421 3520 3421 2501 3520 3141 2792 23141 2792	3969.9 3636.1 3417.4 424.8 3219.5 2706.4 2609.5 2747.6 2626.7 2450.2 4142.9 4142.1 4000.7 3007.4 3254.7 3552.3	13.859 13	1.2177 1.2254 1.7342 1.7342 1.7405 1.7505 1.7005 1.	#8024 7803 7903 7924 7249 1/203 1/20	700 646 590 500 514 401 530 281 281 281 281 281 681 682 683 684 717	-00(5) -00(5)	2.157 2.740 2.742 3.410 4.207 4.187 9.202 4.187 9.202 4.187 9.202 4.102 4.102 4.102 4.102 4.102 4.102 4.102 4.102 4.103 4.203	359.4 371.1 370.5 400.5 410.2 420.9 430.9 440.9 311.6 202.0 214.0 214.0 274.0 249.0	2.236 3.556 2.791 2.676 11.247 16.724 31.231 61.524 102.575 170.764 2.167 1.001 1.001 1.001 1.001 1.000 1.010 1.010	1.267 1.405 1.510 1.510 1.633 1.704 1.764 1.866 1.899 0.000 202 202 201 1.616 7.742 1.023 1.267 1.406 1.517	287. 319. 344. 387. 400. 415. 423. 431. 115. 115. 115. 127.
2.00 40.00 40.00 40.00 40.00 200.00 200.00 200.00 200.00 200.00 1.00 1	\$00.00 150.00 150.00 12.00 14.70 8.00 1.50 1.50 1.50 500.00 571.4; 570.00 570.0	2750 2750 2750 2341 2005 1814 1807 1819 1139 791 870 3526 3421 3203 3141 2792 23141 2792 23151 1851 1851	3969.9 3636.1 3417.4 324.8 3219.9 300.4 2693.0 2742.0 2403.0 4120.1 4000.7 3797.4 3797	13.859 13	1.2177 1.2251 1.2405 1.2405 1.2405 1.2505 1.2951 1.3216 1.3216 1.1982 1.1992 1.1992 1.1992 1.1992 1.2004 1.2004 1.218 1.218 1.2218 1.2304 1.2441	. 4022 7803 7994 7244 1/203 6530 6630 6630 7943 7795 7795 7795 7795 7795 7795 7795 779	700 046 076 066 066 066 066 066 066 066 066 06	000 >9 000 >2 00	2.157 2.940 2.924 2.924 3.100 3.797 4.787 5.801 = 7.14 0.000 2.806 0.206 0	399.4 37/-1 37/-1 370.2 400.2 410.2 420.9 430.2 430.2 40.9 31/-0 20.4 21/-0 21/-	2.236 3.556 3.556 2.791 5.67c 11.247 16.724 31.221 61.524 102.575 170.764 2.167 1.600 1.001 1.001 1.000 1.010 1.010 1.010 1.000 1.010 1.00	1.267 1.405 1.519 1.519 1.633 1.70- 1.764 1.866 1.899 0.000 202 3307 501/ 6/6 1.626 1.406 1.267 1.406 1.517 1.520	287. 319. 344. 344. 400. 415. 423. 431. 0. 431. 103. 24. 27. 209. 309.
2.00 40.00 40.00 40.00 40.00 40.00 100.00 200.00 400.00 1000.00 1000.00 1.00 1.00 1	500-00 14-70 6-00 2-00 14-70 6-00 2-00 1-20 500-00 571-4: 500-00 571-4: 500-00 571-4: 500-00 571-4: 500-00 17-00 500-00 571-4: 500-00 5	2341 2050 2341 2007 2518 2007 2518 2518 2518 2518 2518 2518 2518 2518	3969.9 3636.1 3417.4 3244.8 3219.9 3006.4 2609.0 2749.6 205.0 2749.6 4122.7 450.2 4122.7 309.4 420.1 309.4 325.7 352.2 3247.3 3046.7 2552.9	13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930	1.2177 1.2251 1.2342 1.2342 1.2403 1.2032 1.2032 1.2032 1.3091 1.3024	#8024 7803 1997 1794 1/203 6974 6073 5073 5073 6047 8035 6013 7795	700 646 770 700 646 770 700 646 770 700 646 770 700 646 770 770 770 646 770 770 6470 770 770 770 770 770 770 770 770 770	000 >9 000 >2 00	2.157 2.940 2.924 2.924 3.410 3.797 4.287 4.287 5.801 7.14 0.000 2.000 7.020 7.020 1.1000 1.1000 1.1000 1.291 1.292 2.911 2.921 2.921 2.921 3.406 3.792 3.406	399.4 371.1 370.2 400.3 410.4 430.2 440.9 33 499.2 311.0 602.4 313.0 614.0 624.0 349.0	2.236 3.556 3.556 2.791 2.676 11.247 16.724 31.231 61.524 102.575 170.764 2.167 1.001 1.001 1.001 1.000 1.010 1.010 1.010 1.010 1.010 1.010 1.010 1.010 1.010 1.010 1.010	1.267 1.405 1.516 1.517 1.635 1.704 1.704 1.866 1.899 0.000 2.02 2.02 2.01/ 6/6 2.02 1.406 1.517 1.520	287. 319. 319. 319. 319. 319. 319. 410. 410. 420. 431. 431. 431. 431. 431. 431. 431. 431
2.00 13.00 20.00 40.00 40.00 40.00 200.00 400.00 200.00 1000.00 2000.00 1.00 1.00 1	500-00 14-70 6-00 2-00 14-70 6-00 2-00 1-20 500-00 571-4: 500-00 571-4: 500-00 571-4: 500-00 571-4: 500-00 17-00 500-00 571-4: 500-00 5	2341 2050 2341 2007 2518 2007 2518 2518 2518 2518 2518 2518 2518 2518	3969.9 3636.1 3417.4 3244.8 3219.9 3006.4 2609.0 2749.6 205.0 2749.6 4122.7 450.2 4122.7 309.4 420.1 309.4 325.7 352.2 3247.3 3046.7 2552.9	13.859 13	1.2177 1.2251 1.2342 1.2342 1.2403 1.2032 1.2032 1.2032 1.3091 1.3024	. 4022 7803 7994 7244 1/203 6530 6630 6630 7943 7795 7795 7795 7795 7795 7795 7795 779	700 046 070 070 214 407 407 407 237 248 252 268 272 273 274 275 274 275 277 416	000 >9 000 >2 000 >2 000 >2 000 >2 000 >3 000 >6 00	2.157 2.940 2.940 2.940 3.410 3.799 4.267 4.789 4.272 5.801 0.000 0.286 0.200 0.000 0.	399.4 37/-1 37/-1 37/-1 37/-1 390.2 420.9 420.9 420.9 440.9 31/-0 2/3.0 2/3.0 2/3.0 2/3.0 349.0 34	2.236 3.556 3.556 3.556 11.247 10.724 31.201 170.764 2.167 1.001 1.001 1.001 1.001 1.000 1.001 1.000 1	1.267 1.405 1.519 1.033 1.704 1.764 1.866 1.899 0.000 202 337 202 201 6.742 1.023 1.267 1.406 1.517 1.520 1.520 1.520 1.	287. 319. 319. 319. 319. 319. 319. 319. 319
2.00 4.000 10.000 40.00 40.00 100.000 200.000 400.00 1000.000 1000.000 1	500-00 14-70 6-00 2-00 14-70 6-00 2-00 1-20 500-00 571-4: 500-00 571-4: 500-00 571-4: 500-00 571-4: 500-00 17-00 500-00 571-4: 500-00 5	2341 (205) (3969.9 3636.1 3417.4 3249.8 3219.9 3000.4 2600.0 2722.7 2450.2 4142.0 4142.9 4120.1 3797.4 3797.8 3647.3 3640.7 2658.9 2651.4 2617.6	13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 13.859 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930 14.930	1.2177 1.2251 1.3492 1.4093 1.4093 1.4093 1.4093 1.4093 1.4093 1.4093 1.4009 1.4009 1.4019 1.4022 1.4074 1.4024 1.4009 1.4009 1.4019 1.4024 1.4009	#8024 7803 1997 1794 1/203 6974 6073 5073 5073 6047 8035 6013 7795	700 046 046 046 046 046 046 046 046 046 0	000 >9	2.157 2.940 2.940 2.941 3.100 3.797 4.787 2.872 5.801 - 7.14 0.286 0.286 0.297 1.000 1.100 2.931 2.931 2.931 2.941 2	399.4 37(-1) 37(-1) 370.2 400.2 410.2 420.4 430.2 440.2 340.2	2.236 3.556 3.556 2.791 2.572 4.1.201 61.524 102.575 170.764 2.167 1.000 1.000 1.010 1.010 1.000 2.241 3.566 5.706	1.267 1.405 1.519 1.519 1.633 1.70- 1.76- 1.866 1.899 0.000 202 3307 307 1.676 1.406 1.247 1.526 1.547	287-319-349-349-349-349-349-349-349-349-349-34

TABLE II. - Concluded. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(h) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute; frozen composition during isentropic expansion

ratio.	Static pressure, P,	Temp- erature, T,	h,	Molecular weight	exponent,	Specific heat, c _p ,	Viscos- ity, μ,	Thermal conductivity, k,	Mach number M	Specific impulse in vacuum,	rano,	Thrust coefficient, C _E	Ì I,
P _c /P	hb/sq∙n abs	K	cal/g	993	γ	col/(qi/K)	micro poises	cal/Iseci(OKIIcm)		I _{voc.} (lbiisec)/lb	ε		ilbi(sec)/ilb
			4	? = 1.000	D. PERCE	NT FULL	= 11•1	19. O/F	= 7.93	,			
	630.00		3777.9	15.886	1.1972	0.7592	910	0.00083	0.000	T		0.000	0.0
1.00	571.43	3505		15.886	1.1975	.7584	906	•00083	.286	484.5	2.166	-202	43.2
1.20	500.00	3429	3698.5	15.686	1.1982	.7560 .7533	895 882	•00082 •00080	•556 •760	307.6 274.3	1.260	.389	83.1
1.40	428.57 375.00	334Z 3269	3633.2 3578.0	15.586 15.886	1.1991	.7508	872	•00079	•903	266.8	1.009	-617	131.9
1.77	338.58	3214	J536.6	15.886	1.2005	.7489	854	•00078	1.000	265.6 266.7	1.000	•677 •742	144.9
2.00	300.00 150.00			15.886	1.2012	.7468	801	•00077 •00071	1.609	288.1	1.307	1.040	218.2
									2.157	319.0	2.244	1.267	271.0
40.00	30.00	2390	2933.7	15.886	1.2204	•7115 •6927	130 674	•00063; •00057	2.539	338.9	3.575	1.406	300.7
40.00	15.00	1361	2566.6	15.666	1.2207	.6720 .6714	616 516	•00051 •00051	2.911	356.3	5.833 5.919	1.521	
40.83	14.70	1853	2561.9	15.005	1.2250	.6714	910	1 -0000				•••	
100.00	6.00			15.886	1.2421	.6418	542	•00043 •00037	3.404	374.2	11.363 18.966	1.636	349.9
200.00	3.00 1.50	1362	2244.2	15.886	1.2543	.6169	428	•00032	4.192	395.2	31.744	1.768	378.2
400.00					İ		0.6.6	2/	4.764	405.5	62.740	1.833	392.0
1000.00	•60 •30	967	2011.5 1933.9	15.886		.5609 5403	356 306	•00026 •00021	5.238	411.8	104.909		400 • 6
1000•00! 1000•00!	•15	701	1867.6			.5220	260	•00018	5.755	417.0	175.109	1.906	407.7
		1 .		J	i n. bebce	ENT FUEL	= 7.	749, 0/F	=11.90				
				7		т .		1	0.000			0.000	0.0
1.05	571.43	3374	2626.1	19.463	1.1996	.6129	930	0.00069	.286	427.7	2.168	.202	38 • 2
1.20	500.00	3273	2564.2	19.463	1.2007	6109	914	•00067	•555 •759	271.5	1.260	•389 •525	73.4
1.40	428.57 375.00	3189	2513.4 2470.4	19.463	1.2016	•6086 •6067	901	• 00065	•902	235.4	1.009	.617	116.4
1.77	338.29	3065	2437.8	19.463	1.2030	.6051	881	•00065	1.000	234.4	1.000	•678 •742	
2.00	300.00	3003 2668	2400•6 2200•2	19.463	1.2037	.6032 .5912	871	•00058	1.105	254.1	1.305	1.020	
4.SC	150.00	2000	i			1				281.2	2.238	1.267	239.0
10.00		2272	1969.5	19.463	1.2166	.5735 .5583	737 679	00052	2.157	298.7	3.561	1.405	265.1
20.50 40.00	30.CD		1685.2	19.463	1.2325	-5413	620	+00042	2.913		5.802	1.517	286 • 1 286 • 7
40.00	14.70	1750	1561.5	19.463	1.2321	.5400	517	•00041	2.924	313.7	5.867	1.519	200.1
100.00	6.00	1477	1533.9	19.463	1.2400			• 00035	3.409	329.6	11.282	1.634	300.3
200.00	3.00	1285	1436.3	19.463	1.2019	.4979 .4767	486	+00030	3.797	337.0		1.765	
400.00	1.50	11112	1351.6	17.403	1.42111	•4101	'50		-			1.829	345.1
1000.00			1257.3	19.463		.4548	360 116	•00018 •00051	4.781	356.8	62.045 103.674		
2000.00 4000.00		776	1197.7	19.463					5.780	366.9	172.958	1.901	358 - 7
	1		!	1	- DE: ()	 A * EUEL		1. 927, D/F	! =15-87	9			1
	,		-				1	1			,	T	
1.00			2016.0	21.832		0.5352 .5346	919	0.00060	0.000		2.171	0.000	
1.05	571.43		1964.4	21.632 21.632			900	•00058	. 554	241.9	1.202	• 389	67.0
1.40	428.57	498.	1922.0	- 21.832					• 758 • 700		1.070	•5∠6 •618	
1.60	375.00		1886.2	21.032	1.2050	.5270		•00356	1.000	213.9	1.000	• 680	117.0
2.30	337.01	2804	1320.2	21.032	1.2090	•5202	350	•00055	1-102		1.009	1.021	175.0
4.00	150.00	2483	. 1661.5	21.032	1.2151	.5143	797	•00050	1.607	231.6	1.302	1.021	1,300
10.00	60.00	2105	1470.0	21.832	1.2238				2.157		2.225	1.266	
20.00	30.00	1852					558		2.541		3.530 5.734	1.403	
40.00 40.63	15.00			21.832		.4655			2.929		5.818		
. 0.00	7.00.0			1					3.421	299.5	11.102	1.629	280.
	1												
170.00			1112.6						3.614		18.444		
1:0:00 2:00:00 4:0:00	3.00	1172	1033.0	71.832	1.2009	.4321	465	•00025	3.814		30.731		
200•00 400•00	3.00 1.00	1172 1010	1033.0	21.632 21.632	1.2669	.43cl	465 411	•00044	4.225	7•ف2د . ا	30.731 60.419	1.758	302. . 302.
200•00 400•00 1000•00	3.00 00	1172 1010 822	1033.0 964.3 800.1	21.032 21.032 21.032	1.2977	1354. 4161 23765 23766	465 411 344 296	.00015	4.814 4.225 4.815 5.305	313.7 23.7 320.5	50.751 60.419 100.676	1.758 1.821 1.859	302.
200.00 400.00 1000.00 200.00	3.00 00 .60	1172 1010 822 700	1033.0 964.3 840.2 799.5	21.032 21.032 21.032 21.032	1.2509	1351 14161 2046. 2056.	465 411 344 290 257	.00015 .00015 .00055	3.814 4.225 4.815 5.305 5.841	313.7 23.7 320.5 320.5	30.731 60.419	1.758 1.821 1.859	302.
200.00 400.00 1000.00 200.00	3.00 00 .60	1172 1010 822 700	1033.0 964.3 840.2 799.5	21.032 21.032 21.032 21.032	1.2509	1351 14161 2046. 2056.	465 411 344 290 257	.00015	3.814 4.225 4.815 5.305 5.841	313.7 23.7 320.5 320.5	50.751 60.419 100.676	1.758 1.821 1.859	302.
200.00 400.00 1000.00 2000.00 4000.00	3.000 1.000 .600 .300 .10	1172 1010 822 700 592	1033.0 964.3 840.2 799.5	71.032 21.032 21.032 21.032 21.032	1.2509 1.2800 1.29// 1.3105 1.3/34	.4161 .4161 .3905 .3038 .3720	465 411 344 290 290	.00025 .00042 .00018 .00015 .00012	3.814 4.228 4.815 5.308 5.841 =23.81	313.7	30.731 60.419 100.676 167.527	1.758	302.
200.00 400.00 1000.00 200.00	3.00 1.00 .60 .30 .10	1172 1010 822 700 592 2747 2723	1033-0 964-3 866-1 840-2 799-5	21.832 21.832 21.832 21.832 21.832 R = 3.00 24.718 24.718	1.2509 1.2800 1.2977 1.3100 1.3734 0. PERC	.4321 .4161 .3763 .3722 .3722 ENT FUEL .64502 .4495	460 411 344 290 200 200 860 860	00025 00025 00026 00015 00012 031, 075 0-00048	3.814 4.226 4.815 5.306 5.841 =23.81	313.7 323.7 320.5 332.6	30.731 60.419 100.676 167.527	1.758 1.821 1.859 1.694	304 313 313 313 313 313 313 313
200.00 400.00 1000.00 200.00 4000.00 1.00 1.00	3.00 1.00 .00 .30 .10 600.00 571.43	1172 1010 822 700 592 2747 2723 2659	1033-0 964-3 866-1 840-2 799-5	21.832 21.832 21.832 21.832 21.832 R = 3.00 24.718 24.718	1.2609 1.2800 1.297// 1.3100 2.3754 0, PERC 1.2174 1.2174	.4321 .4161 .3905 .3625 .3720 ENT FUEL .6.4502 .4493	460 411 344 290 200 200 860 860 860	00025 00042 00013 00015 00012 031, 9/F 0.00048 00047	3.814 4.225 4.819 5.305 5.841 =23.81 0.000 .284 .551 .754	313.7 323.7 320.3 332.6 0 0 217.1 193.4	30.731 60.419 100.676 167.527	1.758 1.821 1.859 1.694 0.000 .203 .394	302. 313. 319. 1 329. 0 30. 58. 79.
200.00 420.00 1000.00 200.00 4000.00 1.00 1.00	3.00 1.00 .00 .30 .10 600.00 571.43 500.00 48.57 370.00	1172 1010 822 700 592 2747 2723 2659 2586 2524	1033-0 964-3 866-1 840-2 799-5	21.832 21.832 21.832 21.832 21.832 R = 3.00 24.718 24.718	1.2609 1.2800 1.297// 1.3100 2.3754 0, PERC 1.2174 1.2174	.4321 .4161 .3905 .3625 .3720 ENT FUEL .6.4502 .4493	465 411 344 296 200 869 869 869 869 869 869	00025 00022 00012 00012 00012 031, 0/F 0.00048 00047 00046	3.814 4.225 4.815 5.305 5.841 -23.81 0.000 -284 -551 -754	315.7 323.7 320.5 332.6 0 342.3 217.1 193.4 187.9	30.731 60.419 100.676 167.527	1.758 1.821 1.859 1.899 0.000 203 394 527 619	302. 313. 319. 1.329. 0.30. 30. 58. 79. 93.
200.00 420.00 1000.00 2001.00 4000.00 1.00 1.25 1.40 1.40 1.79	3.00 1.00 .00 .30 .10 600.00 571.43 500.00 48.57 370.00	1172 1010 822 700 592 2723 2656 2524 2475	1033-0 964-3 840-2 799-5 1381-4 1370-7 1341-8 1209-3 1261-9	71.832 21.632 21.632 21.632 21.632 R = 3.00 24.718 24.718 24.718 24.718 24.718	1.2609 1.2800 1.297// 1.3100 1.3734 0. PERC 1.2174 1.2189 1.2189 1.2201 1.2212	.4321 .4161 .37635 .3725 ENT FUEL .4456 .4477 .4436 .4436	460 411 344 296 200 869 869 869 869 810	00025 00022 00012 00012 00012 031, 0/F 0.00048 00047 00046	3.814 4.225 4.815 5.305 5.841 -23.81 0.000 -284 -551 -754	315.7 323.7 320.5 332.6 0 342.3 217.1 193.4 187.9	20.731 60.419 100.676 167.527 1.265 1.064 1.010 1.000	1.758 1.859	302. 313. 314. 325. 0 0. 30. 58. 79. 93. 102.
200.00 400.00 1000.00 2000.00 4000.00 1.00 1.00 1.40 1.40 1.40	3.00 1.00 .00 .30 .10 600.00 571.43 500.00 48.57 370.00	1172 1010 822 700 592 2723 2656 2524 2475	1033-0 964-3 840-2 799-5 1381-4 1370-7 1341-8 1209-3 1261-9	R = 3.00 24.718 24.718 24.718 24.718 24.718 24.718 24.718	1.2609 1.2800 1.297// 1.3100 2.3754 0, PERC 1.2174 1.2174	.4321 .4161 .37035 .3720 ENT FUEL .4475 .4476 .4436 .4426	460 411 344 290 200 860 860 860 860 860	00025 00026 00018 00015 00012 0311 3/F 00048 00048 00045 00046 00046	3.814 4.228 4.819 5.308 5.841 =23.81 0.000 .284 .551 .754 .996 1.009	310.7 320.7 320.7 320.7 320.0 0 0 0 1 193.4 187.9 187.9 187.9 187.9	20.731 60.419 100.676 167.527 1.265 1.064 1.010 1.000	1.758 1.821 1.859 1.899 0.000 203 394 527 685	302. 313. 319. 319. 329. 30. 30. 58. 79. 93. 102. 111.
200.00 420.00 1000.00 2001.00 4000.00 1.00 1.25 1.40 1.60 1.70 2.30 4.30	600-00 571-43 570-00 428-57 370-00 300-00 250-00	1172 1010 822 700 592 2747 2723 2659 2526 2526 2475 2424 2424	1033-0 964-3 840-2 799-5 1381-4 1370-7 1361-9 1261-9 1261-9 1237-2 1110-7	21.832 21.832 21.832 21.832 21.832 21.832 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718	1.2609 1.2800 1.2977 1.3100 2.3754 0. PERC 1.2174 1.2189 1.2201 1.2212 1.2222 1.2222 1.2232	4321 4161 3705 3720 3720 4470 4470 4470 4470 4470 4470 4470	460 411 344 290 290 290 290 860 860 860 860 860 860 860 860 860 86	00025 00026 00018 00018 00015 00012 031, 0/F 0.0048 00047 00046 00047 00046 00047	3.814 4.225 4.815 5.306 5.841 0.000 2.84 5.51 7.74 5.99 1.000	310.7 320.7 320.7 320.0 342.3 217.11 193.4 187.9 187.9 187.9 202.1	20.731 60.419 100.676 167.527 1.265 1.064 1.010 1.006 1.006 1.294	0.000 1.859 1.892 1.892 1.892 1.892 1.892 1.892 1.893 1.893 1.892	302-1 313 313 313 327 30-1 50-1 79 93- 102-1 111 1113-
200.00 420.00 1000.00 2000.00 2000.00 1.00 1.00	600-00 571-43 570-00 330-00 448-57 478-50 330-00 50-00	1172 1010 822 700 592 2747 2723 2659 2566 2476 2478 2424 2423 21/02	1033-0 964-3 840-2 799-5 1381-4 1370-7 1341-8 1201-3 1201-9 1229-0 1237-2 1110-1	R = 3.00 24.718 24.718 24.718 24.718 24.718 24.718 24.718	1.2609 1.2800 1.3794 1.3100 1.3794 0. PERC 1.2174 1.2189 1.2201 1.2212 1.2222 1.2222 1.2229	.4321 .4161 .3403 .3403 .3403 .3403 .4403 .4403 .4403 .4403 .4403 .4403 .4004	462 411 344 296 200 552 638 642 638 642 741	00025 00026 00016 00015 00016 00015 00016 00048 00048 00046 00045 00044 00046 00045	3.814 4.225 4.815 5.841 23.81 0.000 2.84 5.51 -722 -896 1.000 1.090 1.090	310.7 320.5 320.5 320.5 0 342.5 217.1 193.4 187.9	20.731 60.419 100.676 167.527 2.179 1.265 1.064 1.010 1.006 1.274	0.000 1.859	302. 313. 313. 313. 313. 313. 323. 30. 30. 30. 30. 30. 30. 30. 3
200.00 420.00 1000.00 2001.00 4000.00 1.00 1.00 1.00 1.40 1.40	600-000 571-43 500-000 571-43 500-000 340-00 340-00 190-00	1172 1010 822 700 >92 2747 2723 2659 2475 2475 2475 2475 2475 2475 2475 2475	1033.0 964.3 840.2 799.5 1381.4 1370.7 1341.8 1291.3 1261.9 1227.0 1110.7	### 1.052	1.2609 1.2800 1.297// 1.3100 1.3734 0. PEKC 1.2174 1.2189 1.2201 1.2212 1.2222 1.2222 1.2223 1.2236 1.2299	. 43c1 . 41b1 . 34b3 . 34c9 . 345b . 34c9 . 445b . 445b . 44c8 . 44c8 . 44c8 . 44c8 . 44c8 . 44c8 . 44c8 . 44c8 . 44c9 . 44c9 . 44c9 . 44c9 . 44c9 . 44c9 . 44c9 . 4c9	460 411 244 296 200 502 503 503 503 503 503 503 741	00025 00026 00018 00018 00015 00012 031.	3.814 4.226 4.815 5.306 5.841 =23.81 0.000 .284 .551 .754 .996 1.000 1.096 1.000	310.7 323.7 320.0 320.0 320.0 0 342.0 217.1 193.4 187.9 161.0 161.0 161.7 202.1 223.0 247.0	20.731 60.419 100.676 167.527 1.265 1.006 1.006 1.006 1.274 2.195 3.461 5.566	1.79e 1.821 1.829 1.859	302. 313. 313. 313. 313. 313. 30. 30. 30. 30. 102. 111. 213. 210.
200.00 420.00 1000.00 2000.00 4000.00 1.00 1.20 1.40 1.40 1.79 2.30 10.00 10.00	600-000 571-43 500-000 571-43 500-000 340-00 340-00 190-00	1172 1010 822 700 >92 2747 2723 2659 2475 2475 2475 2475 2475 2475 2475 2475	1033.0 964.3 840.2 /99.5 1381.4 1370.7 1341.8 1209.2 1201.9 1110.7 1960.4 1791.1 1707.3	Fi. 832 21. 632 21. 632 21. 632 21. 632 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718 24. 718	1.2609 1.2800 1.277 1.3100 1.3754 1.2178 1.2181 1.2181 1.2620 1.2620 1.2620 1.2620 1.2620 1.2620 1.2620	. 43c1 . 41b1 . 34b3 . 345b . 345b . 345b . 4477 . 445b . 446b . 446b . 446b . 446b . 43c1 . 415z . 43c3 . 34c5	460 411 244 296 200 502 503 503 503 503 503 503 741	00022 00022 00022 00012 00012 011, U/F 00048 00048 00047 00046 00044 00044 00047 00044 00047 00047 00047 00047	3.8144 4.225 4.819 5.305 5.841 0.000 .284 5.51 .752 .096 1.000 2.109 1.000 2.109 1.000 2.109 2.1	310.7 323.7 320.0 0 342.3 247.1 193.4 187.9 1867.0 186.7 202.1 223.0 244.0 247.0 247.0 247.0 247.0 247.0 247.0	30.731 60.419 100.676 167.527 2.179 1.265 1.006 1.006 1.294 2.195 3.461 5.5667	0.000 1.821 1.859 1.	302. 313. 317. 327. 30. 50. 50. 50. 50. 50. 50. 50. 5
200.00 400.00 200.00 200.00 200.00 4000.00 1.00 1.20 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.4	600000 571.43 500.00 100 600.00 110 600.00 110 600.00 110 110 110 110 110 110 110 110 11	1172 1010 822 700 92 2747 2566 2426 2426 2426 2426 2426 2426 2426	1033.0 964.3 864.2 797.5 1381.4 1370.7 1341.8 1261.9 1257.8 110.1 110.1 176.2 1791.1 176.2 1791.1	c1.032 c1.032 c1.032 c1.032 c1.032 c1.032 c1.032 c1.032 c1.032 c4.718 c	1.2609 1.2700 1.2711 1.3100 1.3734 0. PERC 1.2174 1.2181 1	. 4321 . 4161 . 3765 . 3725 . 5720 . 6450 . 6450 . 4450 . 4450 . 4460	460 411 344 296 200 502 600 600 600 600 600 600 600 600 600 6	00042 00042 00012 00012 00012 00012 00014 00047 00044 00044 00044 00047 00046 00047 00046 00047 00046	3.8144 4.225 4.815 5.305 5.841 2.3481 0.000 2.254 1.000 1.009 1.009 2.156 2.742 2.742 2.743 2.744	310.7 323.7 320.7 320.7 322.0 0 342.3 217.1 193.4 187.9 161.0 187.7 202.1 223.0 247.0 247.0 247.0 247.0 247.0 247.0	30.731 60.419 100.576 167.527 2.179 1.265 1.004 1.005 1.006 1.259 2.199 3.451 5.066 7.066	0.0000 203 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654 1.654	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
200.00 400.00 2005.00 2005.00 4000.00 1.00 1.00 1.40 1.40 1.40 1.50 1.70 4.30 4.30 4.30 4.30 4.30 4.30 4.30 4.3	600.00 600.00 571.93 571.93 571.93 570.00 446.57 375.00 336.00 346.00	1172 1010 822 700 592 2747 5 2723 5 2659 2044 5 2475 6 2044 6 2475 6 2044 6 2475 6 2044 6 2475 6 2044 6 2475 6 2044 6 2475 6 2044 6 2475 6 2044 6 2475 6 247	1381.4 1370.7 1381.4 1370.7 1341.8 1309.3 12d1.9 1237.2 1110.7 791.1 760.4	c1.832 21.832 21.832 21.832 21.832 21.832 24.718 2	1.2609 1.2800 1.27/1 1.3100 1.37/9 0. PEKC 1.21/4 1.21/8 1.21/8 1.22/1 1.22/2 1.22/2 1.22/2 1.22/2 1.22/2 1.22/2 1.22/2	.43c1 .41c1 .37cs .3d33 .2fc2 .44c6 .44c6 .44c6 .44c6 .44c6 .45c4 .44c6 .45c4	# 400 # 4 1 344 290 200 860 800 800 800 800 800 800 8	00022 00024 00014 00015 00016 011, 0/F 00048 00048 00047 00046 00044 00047 00046 00046	3.814 4.225 4.815 5.384 5.384 6.000 2.84 5.51 7.74 2.94 1.000 1.000 2.150 2.74 2.74 2.74 2.74 2.74 2.74 3.44 1.85	310.7 323.7 320.7 320.7 322.6 0 0 342.3 217.1 187.9 187	20.731 60.419 100.676 167.527 2.179 1.265 1.006 1.006 1.274 2.195 3.465 5.667	0.000 1.821 1.859 1.	302-1 313-1 317-1 32
220.50 450.50 450.50 2005.50 2005.50 4500.50 1.00 1.00 1.00 1.00 1.00 1.00 1.0	600-000 -000 -100 -100 -100 -100 -100 -1	1172 1010 822 700 592 2743 2723 2659 2524 2475 2475 2475 2475 2475 2475 2475	1381.4 1381.4 1370.7 1341.4 1370.7 1341.8 1307.3 1241.7 1237.2 1110.7 701.6 642.6 592.5		1.2609 1.2800 1.277/ 1.3100 1.3739 0. PEKC 1.2174 1.2189 1.2201 1.2412 1.2422 1.2422 1.2423 1.2423	. 43c1 . 41c1 . 34c5 . 34c5 . 34c5 . 34c6 . 44c6 . 44c6 . 44c6 . 44c6 . 44c6 . 45c1 . 44c6 . 45c1 . 44c6 . 45c1 . 45c2	# 600 4 4 1 4 6 1 5 3 6 4 1 4 6 2 3 6 4 1 4 6 2 3 6 4 1 4 1 4 6 2 3 6 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4	00022 00024 00014 00015 00014 031, 94 00047 00046 00047 00044 00047 00034 00047 00024 00024 00024 00024	3.814 4.22b 4.830b 5.841 0.000 .284 .551 .754 .656 1.000 1.000 2.54 2.54 2.54 2.54 2.54 2.54 2.54 2.54	310.7 323.7 320.5 332.6 0 342.3 217.1 193.4 187.9 167.7 202.1 247.8	30.731 60.419 100.07e 167.527 1.205 1.004 1.016 1.000	1.75e 1.82i 1.859 1.859 1.859 1.872 0.000 200 394 527 1.102 1.102 1.102 1.102 1.102 1.103	302.9 313.9 313.9 313.9 327.9 32
200.00 400.00 400.00 200.00 4000.00 1.00 1.00 1.40 1.40 1.40 1	3.030 1.00 .00 .00 .00 .01 .01 .01 .01 .02 .03 .03 .03 .03 .03 .03 .03 .03 .03 .03	1172 1010 1010 1010 1010 1010 1010 1010	1381-4 1381-4 1381-4 1370-7 1341-8 1391-3 12	21.032 21.032 21.032 21.032 21.032 21.032 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718 24.718	1.2609 1.2800 1.27/1 1.3100 1.37/9 0. PEKC 1.21/4 1.21/8 1.21/8 1.22/1 1.22/2 1.22/2 1.22/2 1.22/2 1.22/2 1.22/2 1.22/2	4 321 4 101 3 405 3 6 35 3 6 35 3 6 35 4 6 5 4 6 7 4 7 4 7 4 9 5 4 9 6 4 9	#650 #411 3444 296 297 869 869 869 869 869 869 869 869	00022 00024 00018 00018 00018 00018 00018 00018 00048 00049 00049 00049 00049 00049 00049 00049 00049 00048 00	3.8144 4.225 5.841 9.865 9.861 9.865 1.0000 1.0000 1	310.7 340.7 340.7 340.7 323.0 0 0 1 193.4 187.9 186.7 202.1 240.8 250.3 240.8 250.3 240.8 250.3 240.8 250.3 240.7 240.8 250.3 240.7 240.8 250.3 240.8 250.3 260.7 260.8	30.731 60.419 100.07e 167.527 1.205 1.004 1.016 1.000	0.0000 201 394 1.657 1.685 1.685 1.685 1.685 1.745 1.022 1.265 1.400 1.5	302. 313. 313. 313. 313. 313. 323. 30. 30. 30. 30. 30. 30. 30. 3

TABLE II. - Concluded. THEORETICAL ROCKET PERFORMANCE AT ASSIGNED PRESSURE RATIOS FROM 1 TO 4000 FOR LIQUID HYDROGEN WITH LIQUID OXYJEN

(h) Concluded. Combustion-chamber pressure, 600 pounds per square inch absolute; frozen composition during isentropic expansion

Pressure ratio, P _C /P	Static pressure, P, Ib/sq in. abs	Temp- erature, T, °K	Enthalpy, h, cal/g	Molecular weight,	Isentropic exponent,	Specific heat, c _{p,} col/(g)(°K)*	Viscos- ity,	Thermal conductivity, k, cal/(sec)(°K)(cm)	Mach number M	Specific impulse in vacuum, I vac, (b)(sec)/lb	Area ratio, E	Thrust coefficient, C _F	Specific impulse I, (b)(sec)/(
				* 4.000	PERCE	NT FUEL	= 3·	054. O/F	=31.74	b		4	
1.00 1.05 1.20	600.00 571.43 500.00	2381 2359 2300	1054.4 1045.7 1022.2	26.323 26.323 26.323	1.2307 1.2312 1.2325	0+4027 +4021 +4003	806 801 788	0.00040 .00040 .00039	0.000 .282 .549	308.7 195.7	2.187 1.269	0.000 .204 .392	0• 27• 52•
1.40 1.60 1.79	428.57 375.00 334.41	2234 2178 2131	995.8 973.6 954.9	26.323 26.323 26.323	1.2340 1.2353 1.2365	.3981 .3963 .3947	774 761 750	+00038 +00037 +00037	.750 .892	174.2 169.2 168.3	1.066 1.011 1.000	.529 .621 .689	71. 83. 93.
2.00 4.00	300.00 150.00	2087 1824	937.6 835.4	26.323 26.323	1.2376	.3932 .3833	740 676	•00036 •00032	1.094	168.8	1.008 1.286		138.
10.00 20.00 40.00	60.00 30.00 15.00	1518 1315 1134	720.1 646.1 582.1	26.323 26.323 26.323	1.2566 1.2665 1.2771	.3697 .3588 .3479	595 537 481	•00028 •00024 •00021	2.155 2.549 2.939	199.8 211.4 221.1	2.166 3.394 5.444	1.263 1.396 1.502	170 188 202
40.83	14.70	1129	580.3	26.323	1.2775	.3476	480	•00021	2.951	221.4	5.521	1.505	203.
100.00 200.00 400.00	6.00 3.00 1.50	926 789 669	511.0 466.2 428.2	26.323 26.323 26.323	1.2927 1.3055 1.3187	•3334 •3226 •3124	412 363 317	.00018 .00015 .00013	3.469 3.889 4.336	231.4 237.7 242.8	10.356 16.972 27.895	1.611 1.676 1.729	217. 226. 233.
000.00	.60 .30 .15	534 447 373	386.7 361.1 339.7	26.323 26.323 26.323	1.3363 1.3489 1.3586	.3000 .2918 .2860	262 225 191	•00010 •00009 •00007	4.980 5.518 6.112	248.3 251.6 254.3	53.871 88.590 145.580	1.785 1.819 1.847	241 245 249
		LI	R	= 5.000	, PERCE	NT FUEL	= 2.4	58, O/F	=39-683)			
1.00	600.00 571.43	2072 2052	855.0 847.7	27.317 27.317	1.2436	0.3714	742 737	0+00034 +00034	0.000	282.6	2.194	0.000	25.
1.40	500.00 428.57	1999	828.0	27.317	1.2475	.3691 .3671	725 710	•00033 •00033	•>46 •747	179.0	1.272	.394 .531	48 •
1.60 1.80 2.00 4.00	375.00 332.87 300.00 150.00	1888 1844 1806 1568	771.2 757.4	27.317 27.317 27.317 27.317	1.2487 1.2500 1.2512 1.2595	.3653 .3637 .3623 .3531	698 687 677 614	•00032 •00031 •00031 •00027	.888 1.000 1.090 1.594	154.6 153.7 154.2 165.4	1.012 1.000 1.007 1.279	.623 .694 .748 1.023	76. 85. 92. 126.
10.00 20.00 40.00 40.83	60.00 30.00 15.00 14.70	1294 1113 953 949	577.3 516.7 464.7 463.3		1.2720 1.2824 1.2937 1.2940	•3402 •3303 •3204 •3201	536 481 429 428	+00023 +00020 +00018 +00018	2.154 2.553 2.950 2.962	181.8 192.1 200.7 200.9	2.139 3.335 5.318 5.393	1.262 1.393 1.497 1.499	155. 171. 184.
100.00 200.00 400.00	6.00 3.00 1.50	771 652 549	407.4 371.6 341.3	27.317 27.317 27.317	1.3104 1.3237 1.3373	•3071 •2975 •2884	364 319 277	•00314 •00012 •00011	3.490 3.923 4.385	209.7 215.2 219.6	10.039 16.351 26.706	1.603 1.665 1.717	197. 205. 211.
000.00	•60 •30 •15	434 361 300	308.7 288.7 272.1	27.317 27.317 27.317	1.3544 1.3638 1.3701	•2780 •2727 •2693	228 193 163	•00008 •00007 •00006	5.055 5.621 6.245	224.3 227.1 229.4	51.154 83.660 136.905	1.770 1.803 1.829	218. 222. 225.
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TABLE III. - THERMODYNAMIC DERIVATIVES AT ASSIGNED FRESSURE RATIOS

FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equilibrium composition during isentropic expansion. Equivalence ratio, R; oxidant-fuel ratio, $\mbox{O/F.]} \label{eq:fig:property}$

(a) Combustion-chamber pressure, 60 pounds per square inch absolute

							1	r	
Pressure ratio, P _C /P	Temp- erature, T,	Temp- erature exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat,	(ð in 100) d in P)	(ðln97≀) (ðln T)
'c''	°K	i n ₁		"E	(lb)(sec)/lb	n ₁	col/(g)(°K)	` '1	` '
		D = 0.	L5, PERC	ENT FUEL	* 45.6	5. O/F	= 1.190		
-	Γ	K - U.	D) PERC	THI FUEL	- 45.6	0,1			
1.00	1183	0.0000					1.7753	0.00000	0.000
1 • 05	1168	•0000	2.250	0.0000	47.4	0.0000	1.7711	•00000	•0000
1+20	1129	•0000	1.297	+0000	90.8	•0000 •0000	1.7597	•00000 •00000	•0000
1.40 1.60	1085	•0000	1.018	•0000	143.2	•0000	1.7369	•00000	•000
1.87	1008	•0000	1.000	•0000	163.4	•0000	1.7257	•00000	•000
2.00	989	•0000	1.003	+0000	171.5	•0000	1.7210	•00000	-000
4+90	824	-0000	1.233	•0000	232.3	•0000	1.6826	•00000	•0000
4.08	819	•0000	1.244	•0000	233.7	•0000	1.6816	•00000	•000
10.00	643	•0000	1.974	•0000	283-1	•0000	1.6507	•00000	• 000
20.00	532	•0000	2.983	•0000	309.9	•0000	1.6343	•00000	*0000
40.00	439	•0000	4+620	•0000	330 • 4	•0000	1.0200	•00000	*000
100.00	340	•0000	8 • 4 3 2	•0000	350.8	•0000	1.6099	•00000	•000
200.00	280	•0000	13-431	•0000	362 • 6	•0000	1.5951	•00000	• 0000
400 • 00	230	•0000	21.488	•0000	372.0	•0000	1.5573	•00000	•000
000+00	175	•0000	39.928	•0000	381.6	•0000	1.4871	•00000	•000
2000+00	142	•0000	63.572	•0000	387.2	•0000	1 - 4402	•00000	•000
000-00	114	•0000	100.939	•0000	391.6	•0000	1-4116	•00000	• 0000
		R = 3.2	n. PERC	ENT FUEL	= 38.6	5. 0/F	= 1.587		
	Ī		, , , ,		3000				-0.000
1.00	1514	0.0000	2.233	0.0000	49.3	0.0000	1.6194	• 00000	-0.000
1.05 1.20	1450	•0000	1.289	+0000	94.6	•0000	1.6028	•00000	•000
1.40	1398	•0000	1.077	•0000	127.4	•0000	1.5891	•00000	•000
1+60	1354	•0000	1.016	•0000	149.4	•0000	1.5774	•00000	•000
1.85	1307	•0000	1.000	•0000	165.2	•0000	1.5653	•00000	•000
2 • 00	1282	•0000	1.004	•0000	179+1	+0000	1 • 5585	•00000	•000
4 • 10	1079	•0000	1.244	•0000	243.2	•0000	1.5046	• 00000	•000
4.08	1073	•0000	1.256	•0000	244.1	•0000	1.0001	•00000	-000
10.00	852	•0000	2.009	•0000	297.2	•0000	1.4516	•00000	•000
20.00	709	•0000	3.049	•0000	325.9	•0000	1.4232	•00000	•000
40.00	588	•0000	4.739	+0000	348 • 0	•0000	1-4067	•00000	•0000
100.00	458	•0000	8 • 679	•0000	370.0	•0000	1.3916	•00000	•000
200.00	379	•0000	13.870	•0000	382 • 7	•0000	1.3807	•00000	•000
400.00	312	•0000	22.296	•0000	393.0	•0000	1.3681	•00000	•000
000.00	242	•0000	41.979	•0000	403.5	-0000	1.3398	•00000	•000
2000 • 00	198	•0000	67-687	•0000	409.7	•0000	1.2994	•00000	•000
000.00	161	•0000	108.755	•0000	414.6	•0000	1 • 2564	•00000	•000
		R = 0 • 2	25. PERC	ENT FUEL	= 33.5	1. 0/F	= 1.984		
1.00	1816	0.0003					1.5088	0+00004	-0.001
1.05	1797	•0003	2.218	0.0001	50.3	0.0001	1.5036	•00004	001.
1.20	1744	•0002	1.283	•0001	96.6		1.4898		000
1.40	1686	•0001				• 0001	104090	•00003	1 -000
1.60	1636	****	1.073	•0000	130.1	*0001	1.4751	•00003 •00002	- •000
1.63	1	•0001	1.015	•0000	130•1 152•6	•0001 •0001	1.4751	.00002 .00001	- •000
	1587	•0001 •0000	1.015	•0000 •0000	130 • 1 152 • 6 171 • 8	*0001 *0001	1.4751 1.4630 1.4513	.00002 .00001	000
2 • 00	1555	•0001 •0000 •0000	1.015 1.000 1.005	•0000 •0000 •0000	130 • 1 152 • 6 171 • 8 183 • 1	*0001 *0001 *0001	1.4751 1.4630 1.4513 1.4436	.00002 .00001 .00001	- •000 - •000 - •000
4 • 00 4 • 08		•0001 •0000 •0000	1.015	•0000 •0000	130 • 1 152 • 6 171 • 8	*0001 *0001	1.4751 1.4630 1.4513	.00002 .00001	- •000 - •000 - •000 •000
4 • 00 4 • 08	1555 1322 1316	•0001 •0000 •0000 •0000	1.015 1.000 1.005 1.256 1.268	.0000 .0000 .0000 .0000	130+1 152+6 171+8 183+1 249+3 250+8	.0001 .0001 .0001 .0001 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860	.00002 .00001 .00001 .00000 .00000	- •000 - •000 - •000 - •000 •000
4.00 4.08	1555 1322 1316	.0001 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268	.0000 .0000 .0000 .0000 .0000	130+1 152+6 171+8 183+1 249+3 250+8	.0001 .0001 .0001 .0001 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860	.00002 .00001 .00001 .00000 .00000	000 000 000 000 000
4.00 4.08 10.00 20.00	1555 1322 1316	.0001 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268	.0000 .0000 .0000 .0000	130+1 152+6 171+8 183+1 249+3 250+8	.0001 .0001 .0001 .0001 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860	.00002 .00001 .00001 .00000 .00000	000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00	1555 1322 1316 1057 887 741	.0001 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883	.0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0	*0001 *0001 *0001 *0001 *0000 *0000 *0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559	.00002 .00001 .00001 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00	1555 1322 1316 1057 887 741 581	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883	.0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4	.0001 .0001 .0001 .0001 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00 100.00 200.00	1555 1322 1316 1057 887 741	.0001 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883	.0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0	*0001 *0001 *0001 *0001 *0000 *0000 *0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559	.00002 .00001 .00001 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	1555 1322 1316 1057 887 741 581 482 399	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883 8.985 14.396 23.208	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559 1.2321 1.2190 1.2100	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000	
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	1555 1322 1316 1057 887 741 581 482 399 310	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883 8.985 14.396 23.208	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	1555 1322 1316 1057 887 741 581 482 399 310 256	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883 8.985 14.396 23.208	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2248 1.2559 1.2321 1.2190 1.2100 1.1943	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	1555 1322 1316 1057 887 741 581 482 399 310	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883 8.985 14.396 23.208 43.894 71.279 115.650	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 362.4 391.9 406.8 418.1 424.7 430.2	.0001 .0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559 1.2321 1.2190 1.2100 1.1943 1.1803 1.1487	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 200.00	1555 1322 1316 1057 887 741 581 482 399 310 256 210	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 2.048 3.127 4.883 8.985 14.396 23.208 43.894 71.279 115.650	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 362.4 391.9 406.8 418.1 424.7 430.2	.0001 .0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2259 1.2321 1.2190 1.2100 1.1943 1.1803 1.1487	-00002 -00001 -00001 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000	000 000 000 000 000 000 000 000 000 000 000 000 000 000
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 200.00 400.00	1555 1322 1316 1057 887 741 581 482 399 310 256 210	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.256 1.256 1.256 1.274 4.883 8.985 14.396 23.208 71.279 115.650	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 362.4 395.9 406.8 418.1 424.7 430.2	.0001 .0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.22849 1.2599 1.2321 1.2190 1.2100 1.1487 2.381	.0002 .0001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 1000.00 1000.00	1555 1322 1316 1057 887 741 581 482 399 310 256 210	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.268 3.127 4.883 8.985 14.396 23.208 43.894 71.279 115.650	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2 = 29.5	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.2259 1.22190 1.2190 1.1943 1.1863 1.1487 2.381 1.487 1.487	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 100.00 100.00	1555 1322 1316 1057 887 741 581 482 399 310 256 210	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.256 1.256 1.256 1.274 4.883 8.985 14.396 23.208 71.279 115.650	.0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 362.4 395.9 406.8 418.1 424.7 430.2	.0001 .0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3860 1.3226 1.22849 1.2599 1.2321 1.2190 1.2100 1.1487 2.381	.0002 .0001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	-0.008 -000 -000 -000 -000 -000 -000 -00
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 1000.00 1000.00	1555 1322 1316 1057 887 741 581 482 399 310 256 210	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.256 2.048 3.127 4.883 14.396 23.208 43.894 71.279 115.650	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2 = 29.5	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3880 1.3226 1.2845 1.2559 1.2321 1.2190 1.2100 1.1943 1.1803 1.1467 2.381 1.4578 1.4578 1.4578 1.4692 1.4276 1.4052	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	
4.00 4.08 10.00 20.00 40.00 100.00 200.00 4000.00 1000.00 1.00 1.05 1.20 1.40	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2069 2013 1950	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.015 1.000 1.005 1.256 1.258 2.048 3.127 4.8893 14.396 23.208 43.894 71.279 115.650 30, PERC	.0000 .0000	130.1 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2 = 29.5	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4387 1.3880 1.3226 2.2848 1.2559 1.2100 1.2100 1.2100 1.1943 1.1803 1.487	0.0002 0.0001 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	
10.00 40.00 10.00 20.00 40.00 100.00 200.00 400.00 1000.00 1000.00 1000.00 1.05 1.20 1.40 1.40 1.40 1.40	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2069 2013 1950 1896 1896 1808	.0001 .0000	1.015 1.000 1.005 1.256 2.048 3.127 4.883 8.985 14.396 23.208 43.894 71.279 115.650 2.204 1.277 1.070 1.013 1.000	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 424.7 430.2 = 29.5	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3880 1.3226 1.2848 1.2559 1.2210 1.2100 1.1943 1.1807 1.1487 2.381 1.4578 1.4	-00002 -00001 -00001 -000000	
4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 1000.00 1000.00 1.00 1.05 1.20 1.40 1.40 1.82 2.400	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2013 1950 1896 1846 1846 1846 1553	.0001 .0000	1.015 1.000 1.005 1.256 1.258 2.048 3.127 4.8893 14.396 23.208 43.894 71.279 115.650 30. PERC	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.6 335.6 335.6 392.9 392.9 406.8 418.1 424.7 430.2 = 29.5	-0001 -0001 -0001 -0000	1.4751 1.4630 1.4513 1.4387 1.3880 1.3880 1.3226 1.2848 1.2559 1.2190 1.2190 1.2190 1.1943 1.1803 1.1487 1.4877 1.497 1.	-00002 -00001 -00001 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000	
10.00 40.00 10.00 20.00 40.00 100.00 200.00 400.00 1000.00 1000.00 1000.00 1.05 1.20 1.40 1.40 1.40 1.40	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2069 2013 1950 1896 1896 1808	.0001 .0000	1.015 1.000 1.005 1.256 2.048 3.127 4.883 8.985 14.396 23.208 43.894 71.279 115.650 2.204 1.277 1.070 1.013 1.000	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 424.7 430.2 = 29.5	.0001 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4751 1.4630 1.4513 1.4436 1.3875 1.3880 1.3226 1.2848 1.2559 1.2210 1.2100 1.1943 1.1807 1.1487 2.381 1.4578 1.4	-00002 -00001 -00001 -000000	
4.00 4.00 10.00 20.00 40.00 200.00 200.00 400.00 1000.00 1000.00 1.00 1.00 1	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2013 1950 1896 1846 1846 1853 1546	.0001 .00000 .000	1.015 1.000 1.000 1.268 2.048 3.127 4.883 14.396 23.208 43.894 71.279 115.650 30, PERC	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.6 335.6 395.9 396.8 418.1 424.7 430.2 50.7 97.4 131.3 154.1 172.5 185.1 252.5 254.1	-0001 -0001 -0001 -0000	1.4751 1.4630 1.4513 1.4387 1.3880 1.3880 1.3226 1.2848 1.2559 1.2190 1.2190 1.2190 1.1943 1.1803 1.1487 1.4877 1.497 1.	-00002 -00001 -000000	
1.00 1.00	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2063 1950 1896 1846 1808 1558	.0001 .0000	1.015 1.000 1.005 1.256 1.258 2.048 3.127 4.8893 14.396 23.208 43.894 71.279 115.650 30. PERC	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.6 335.6 335.6 392.9 392.9 406.8 418.1 424.7 430.2 = 29.5	-0001 -0001 -0001 -0000	1.4751 1.4630 1.4513 1.4387 1.3880 1.3880 1.3226 1.2848 1.2559 1.2190 1.2190 1.1943 1.1803 1.1803 1.1803 1.4276 1.4493 1.4052 1.3879 1.3623 1.	-00002 -00001 -00001 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000	
4.00 4.00 10.00 20.00 40.00 200.00 200.00 400.00 1000.00 1000.00 1.00 1.00 1	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2013 1950 1896 1846 1846 1853 1546	.0001 .00000 .000	1.015 1.000 1.005 1.256 1.256 2.048 3.127 4.883 8.985 14.396 23.208 71.279 115.650 30. PERC 2.204 1.277 1.070 1.013 1.000 1.256 1.276	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 395.9 362.4 395.9 395.9 395.9 395.9 395.9 395.9 395.9 395.9 395.9 1424.7 430.2 29.5	.0001 .0001 .0001 .0000	1.4751 1.4630 1.4913 1.4436 1.3875 1.3860 1.3226 1.2848 1.2559 1.2190 1.2190 1.2190 1.2190 1.1803 1.1487 2.3879 1.4276 1.4078 1.	0.0002 0.0001 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	000 000
10.00 20.00 40.00 20.00 40.00 200.00 200.00 200.00 2000.00 2000.00 1.05 1.20 1.40 1.82 2.00 4.00 4.00 4.00 4.00 4.00 4.00 4.0	1555 1322 1316 1057 887 741 581 482 399 310 256 210 2089 2013 1950 1896 1846 1808 1553 1546 1258 1064 896	-0001 -0000	1.015 1.000 1.000 1.206 1.256 2.048 3.127 4.883 8.985 14.396 23.208 43.897 115.650 30. PERC 2.204 1.277 1.073 1.000 1.266 1.278 2.208	.0000 0	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 97.4 131.3 154.1 172.5 185.1 172.5 185.1 185.1 252.5 254.1 310.4 365.9		1.4751 1.4630 1.4513 1.4436 1.3875 1.3880 1.3226 1.2848 1.2559 1.2190 1.2190 1.2100 1.1943 1.1803 1.1487 1.4457 1.4652 1.3879 1.3623 1.3008 1.2932 1.3008 1.2932 1.	.00002 .00001 .00001 .00000	
10.00 40.00 10.00 20.00 40.00 100.00 200.00 400.00 100.00 1000.00 1000.00 1000.00 1.00 1.05 1.20 1.40 1.40 1.65 1.20 4.08 10.00 20.00 1.00	1555 1322 1316 1057 741 581 482 399 310 256 210 2089 2069 2013 1950 1896 1846 1808 1558 1546 1258 1758 1758 1758 1758 1758 1758 1758 17	.0001 .0000	1.015 1.000 1.005 1.256 1.256 2.048 3.127 4.8833 8.985 14.396 23.208 43.894 71.279 115.650 20. PERC 2.204 1.277 1.013 1.000 1.266 1.278 2.085 3.207 5.038 9.326	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.6 335.7 359.0 382.4 390.9 418.1 424.7 430.2 = 29.5 50.7 971.3 154.1 172.5 254.1 310.4 341.6 34		1.4751 1.4630 1.4513 1.4387 1.3880 1.3226 1.2559 1.2321 1.2190 1.2190 1.1803 1.1803 1.1487 1.487 1.487 1.493 1.497 1.497 1.493 1.497 1.3729 1.3729 1.3729 1.3729 1.3729 1.3729 1.373 1.3008 1.2992	-00002 -00001 -00000	
4.00 4.00 20.00 20.00 40.00 100.00 200.00 400.00 400.00 1000.00 1.00 1.20 1.40 1.82 2.00 4.00 4.00 4.00 4.00 4.00 4.00 10.00 1	1555 1322 1316 1057 887 741 581 482 399 310 225 211 1950 1896 1896 1896 1553 1546 1258 1064 896 708	.0001 .0000	1-015 1-000 1-005 1-256 1-268 2-048 3-127 4-883 8-985 14-396 23-208 43-894 71-277 10-70 10-013 1-000 1-266 1-276 3-207 5-038 9-326 14-395	.0000 0	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 50.7 97.4 131.3 154.1 172.5 185.1 185.1 252.5 254.1 310.4 410.9 410.		1.4751 1.4630 1.4513 1.4436 1.3875 1.3880 1.3226 1.22559 1.2321 1.2190 1.2100 1.1943 1.1803 1.1487 2.381 1.4578 1.4052 1.3879 1.3623 1.3008 1.2992 1.2337 1.1691 1.174		
10.00 40.00 10.00 20.00 40.00 100.00 200.00 400.00 100.00 1000.00 1000.00 1000.00 1.00 1.05 1.20 1.40 1.40 1.65 1.20 4.08 10.00 20.00 1.00	1555 1322 1316 1057 741 581 482 399 310 256 210 2089 2069 2013 1950 1896 1846 1808 1558 1546 1258 1758 1758 1758 1758 1758 1758 1758 17	.0001 .0000	1.015 1.000 1.005 1.256 1.256 2.048 3.127 4.8833 8.985 14.396 23.208 43.894 71.279 115.650 20. PERC 2.204 1.277 1.013 1.000 1.266 1.278 2.085 3.207 5.038 9.326	.0000 .0000	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.6 335.7 359.0 382.4 390.9 418.1 424.7 430.2 = 29.5 50.7 971.3 154.1 172.5 254.1 310.4 341.6 34	.0001 .0001 .0001 .0000	1.4751 1.4630 1.4513 1.4387 1.3880 1.3226 1.2559 1.2321 1.2190 1.2190 1.1803 1.1803 1.1487 1.487 1.487 1.493 1.497 1.497 1.493 1.497 1.3729 1.3729 1.3729 1.3729 1.3729 1.3729 1.373 1.3008 1.2992	-00002 -00001 -00000	
10.00 20.00 40.00 100.00 200.00 40.00 000.00 000.00 100.00 1.00 1.	1555 1322 1316 1057 887 741 581 482 399 310 225 211 1950 1896 1896 1896 1553 1546 1258 1064 896 708	.0001 .0000	1-015 1-000 1-005 1-256 1-268 2-048 3-127 4-883 8-985 14-396 23-208 43-894 71-277 10-70 10-013 1-000 1-266 1-276 3-207 5-038 9-326 14-395	.0000 0	130.1 152.6 171.8 183.1 249.3 250.8 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 50.7 97.4 131.3 154.1 172.5 185.1 185.1 252.5 254.1 310.4 410.9 410.		1.4751 1.4630 1.4513 1.4436 1.3875 1.3880 1.3226 1.22559 1.2321 1.2190 1.2100 1.1943 1.1803 1.1487 2.381 1.4578 1.4052 1.3879 1.3623 1.3008 1.2992 1.2337 1.1691 1.174		

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equilibrium composition during isentropic expansion. Equivalence ratio, R; oxidant-fuel ratio, 0/F.]

(a) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute

	Temp- erature, T,	Temp- erature exponent,	Area ratio,	Area- ratio exponent,	Specific impulse,	Specific impulse exponent,	Specific heat,	(ðin TR ðin P)	(ð ln 🎹) (ð ln T)
P _c /P	°K	U,	ε	°E	(lb)(sec)/lb	n ₁	cal/(g/(°K)	(5111 / /-	(0)
		R = 0•	S PERC	ENT FUEL	= 26.4	7. O/F	= 2.778	,	
	2329	0.0052			İ		1.4897	0.00122	-0-029
1.00 1.05	2309	•0048	2.189	0.0018	50.7	0.0020	1.4752	+00112	- •027
1.20	2253	•0039	1.270	•0012	97.5	•001E	1.4382	•00089	022
1.40	2189	•0030	1.067	•0007	131.5	-0016	1.3999	• 00067	017
1.60	2133	•0023	1.012	•0003	154.4	•0014	1.3707	+00051	013
1.80	2085	•0018	1.000	•0000	171.8	•0013	1.3475	+00040	010
2.00	2042	.0014	1.007	0002	185.6	•0012	1.3289	•00032	- •008
4.00	1772	00C1	1.277	0010	253.8	•0007	1.2391	•00006	- •001
4.08	1764	0001	1.289	0010	255.4	•0007	1.2371	•00005	- •001
10.00	1452	- 2006	2.121	0010	312.8	+0004	1.1665	•00000	- •000
10.00	1239	0005	3.285	0009	345.0	•000	1.1208	•00000	•000
20.00 40.00	1051	0006	5.194	0009	370 - 1	•0004	1.0795	•00000	•000
.0-00	1022	10000							
100.00	838	0006	9.687	0008	395.7	•000	1.0366	•00000	•000
200.00	703	0006	15.643	0008	410.7	•000	1.0120	•00000	•000
400 • 20	587	-•0006	25.377	-•0008	422.9	•000	•9954	•00000	•000
		_				>	9700		-000
1000 • 00	460	0007	48.339	0008	435 • 5	•0001	•9790 •9694	•00000	•000
000.00	382	0007	78.934	0008	443.0	•0001	•9600	•00000	•000
000.00	317	-+0007	129.082	-•0008	449.2	•0000	*7000	1 00000	
	,	R = 0+4	O. PERC	ENT FUEL	= 23.9	5 • 0/F	= 3.175		
1.00	2531	0.0105		1	i		1.6075	0.00316	-0.071
1.05	2512	•0100	2.173	0.0029	50.4	0.0035	1.5870	. 00296	- •067
1.20	2458	.0086	1.263	•0021	96.9	003	1.5334	•00248	057
1.40	2396	•0071	1.063	•0012	130.8	•0034	1.4758	•00198	- •046
1.60	2342	+0059	1.010	•0005	153.8	003	1+4300	•00162	- •039
1.78	2298	•0050	1.000	•0000	169.9	•0031	1.3954	•00136	033
2.00	2252	•0041	1.008	0005	184.9	•002£	1.3620	•00112 •00028	- •027
4.00	1978	•0004	1.289	0026	253.7 255.3	•0014	1.2116	•00027	007
4.08	1970	•0004	1.302	0026	22343	+0014	1.2110	*00027	•00.
10.00	1640	0011	2.160	0031	313.6	•001-	1.1161	•00003	000
20.00	1411	0014	3+365	0030	346.5	\$000 t	1.0681	•00000	000
40.00	1207	0015	5.356	0029	372 • 4	•000¢	1.0259	•00000	•000
						1	1		
100.00	972	0015	10.068	0028	398.9	•0004	•9772	•00000	•000
200.00	820	0016	16.345	0028	414.5	• 0000	•9481	•00000	• 000
400.00	689	0016	26.628	0027	427.3	• 000	•9252	•00000	• 000
				037		000	-9041	- 00000	•000
1000.00	543	0017	50.955	0027	440.6	•000	•9041 •8930	•00000	•000
2000 • 00	453 377	0017	83.421 136.777	0027	455.1	•000-	-8834	-00000	•000
+000-00	1 34.	0017	1300	1000				1	1 ;
	Т	R = 3.4	5, PERC	ENT FUEL	= 21.8	7 • 0/f	= 3.571 	T	T
1.00	2696	0.0164					1.7899	0.00627	-0.134
1.05	2678	.0158	2.159			0.0060	1.7649	•00597	
				0.0033	49.9		1 2 6000		
1.20	2628	•0143	1.257	•0025	96+0	+005₺	1.6982	•00>19	113
1.40	2570	.0126	1.257 1.060	•0025 •0015	96+0 129+6	+0054 +0054	1.6247	•00519 •00438	113
1.40 1.60	2570 2519	.0126 .0111	1.257 1.060 1.009	•0025 •0015 •0006	96.0 129.6 152.4	•0054 •0054	1.6247	.00519 .00438 .00374	113 097 084
1.40 1.60 1.77	2570 2519 2481	.0126 .0111 .0100	1.257 1.060 1.009 1.000	•0025 •0015 •0006 •0000	96.0 129.6 152.4 167.2	•0054 •0054 •0054	1.6247 1.5642 1.5208	.00519 .00438 .00374 .00330	113 097 084 075
1.40 1.60 1.77 2.00	2570 2519 2481 2434	.0126 .0111 .0100 .0087	1.257 1.060 1.009 1.000 1.010	•0025 •0015 •0006 •0000	96.0 129.6 152.4 167.2 183.5	•0054 •0054 •0054 •0054	1.6247 1.5642 1.5208 1.4702	.00519 .00438 .00374 .00330 .00281	113 097 084 075 065
1.40 1.60 1.77 2.00 4.20	2570 2519 2481 2434 2167	.0126 .0111 .0100 .0087 .0024	1.257 1.060 1.009 1.000 1.010 1.303	•0025 •0015 •0006 •0000 •0008	96.0 129.6 152.4 167.2 183.5 252.4	•0054 •0054 •0054 •0054 •004 •0034	1.5247 1.5642 1.5208 1.4702 1.2440	.00519 .00438 .00374 .00330 .00281 .00095	113 097 084 075 065
1.40 1.60 1.77 2.00	2570 2519 2481 2434	.0126 .0111 .0100 .0087	1.257 1.060 1.009 1.000 1.010	•0025 •0015 •0006 •0000	96.0 129.6 152.4 167.2 183.5 252.4 254.0	•0054 •0054 •0054 •0054	1.6247 1.5642 1.5208 1.4702	.00519 .00438 .00374 .00330 .00281	113 097 084 075 065 024
1.40 1.60 1.77 2.00 4.00 4.08	2570 2519 2481 2434 2167	.0126 .0111 .0100 .0087 .0024 .0023	1.257 1.060 1.009 1.000 1.010 1.303	•0025 •0015 •0006 •0000 •0008	96.0 129.6 152.4 167.2 183.5 252.4	.0054 .0054 .0054 .0054 .0054 .0034 .0035	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389	.00519 .00438 .00374 .00330 .00281 .00095 .00091	113 097 084 075 024 023
1.40 1.60 1.77 2.00 4.00 4.08	2570 2519 2481 2434 2167 2159 1822 1581	.0126 .0111 .0100 .0087 .0024 .0023	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454	.0025 .0015 .0006 .0000 0008 0044 0045	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5	.005! .005! .005! .005! .004! .003! .003!	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282	.00519 .00438 .00374 .00330 .00281 .00095 .00091	113 097 084 075 065 024 023
1.40 1.60 1.77 2.00 4.70 4.08	2570 2519 2481 2434 2167 2159	.0126 .0111 .0100 .0087 .0024 .0023	1.257 1.060 1.009 1.000 1.010 1.303 1.316	.0025 .0015 .0006 .0000 0008 0044 0045	96.0 129.6 152.4 167.2 183.5 252.4 254.0	.0054 .0054 .0054 .0054 .0054 .0034 .0035	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389	.00519 .00438 .00374 .00330 .00281 .00095 .00091	113 097 084 075 065 024 023
1.40 1.60 1.77 2.00 4.00 4.08 10.00 20.00 40.00	2570 2519 2481 2434 2167 2159 1822 1581 1362	.0126 .0111 .0100 .0087 .0024 .0023	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529	-0025 -0015 -0006 -0000 -0008 0044 0045 0064 0064	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1	.0054 .0054 .0054 .0054 .0034 .0034 .0034 .0031	1.6247 1.5642 1.5208 1.4702 1.22440 1.2389 1.0871 1.0282 .9843	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00013 .00002	113 097 084 075 024 023
1.40 1.60 1.77 2.00 4.00 4.00 20.00 40.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109	-0126 -0111 -0100 -0087 -0024 -0023 0016 0025 0027	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529	-0025 -0015 -0006 -0000 -0008 0044 0045 0064 0064	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1	.0054 .0054 .0051 .0051 .0041 .0034 .0034 .0034 .002	1.6247 1.5642 1.5208 1.4702 1.22440 1.2389 1.0871 1.0282 .9843	.00519 .00438 .00374 .00330 .00281 .00095 .00091	113 097 084 075 065 024 023 000
1.40 1.60 1.77 2.00 4.00 4.08 10.00 20.00 40.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942	-0126 -0111 -0100 -0087 -0024 -0023 0016 0025 0027 0029 0030	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529	-0025 -0015 -0006 -0000 -0008 0044 0045 0064 0064 0062 0061	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1	.0054 .0054 .0055 .0056 .0044 .0034 .0034 .0024 .0014 .0014 .0006	1.6247 1.5642 1.5208 1.4702 1.22440 1.2389 1.0871 1.0282 .9843 .9335	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00013 .00002 .00000	113 097 084 075 065 024 023 000 000
1.40 1.60 1.77 2.00 4.00 4.00 20.00 40.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109	-0126 -0111 -0100 -0087 -0024 -0023 0016 0025 0027	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529	-0025 -0015 -0006 -0000 -0008 0044 0045 0064 0064	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1	.0054 .0054 .0051 .0051 .0041 .0034 .0034 .0034 .002	1.6247 1.5642 1.5208 1.4702 1.22440 1.2389 1.0871 1.0282 .9843	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00013 .00002 .00000	113 097 084 075 065 024 023 000 000
1.40 1.60 1.77 2.00 4.70 4.08 10.00 20.00 40.00 100.00 200.00 40.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942	-0126 -0111 -0100 -0087 -0024 -0023 0016 0025 0027 0029 0030	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529	-0025 -0015 -0006 -0000 -0008 0044 0045 0064 0064 0062 0061	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1	.0054 .0054 .0055 .0056 .0044 .0034 .0034 .0024 .0014 .0014 .0006	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .00000 .00000	112 097 084 075 065 024 002 000 000 000 000 000
1.40 1.60 1.77 2.00 4.00 4.08 10.00 20.00 40.00 100.00 200.00 40.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796	-0126 -0111 -0100 -0087 -0024 -0023 0025 0027 0027 0030 0031	1.257 1.060 1.009 1.000 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516	-0025 -0006 -0000 -0008 -0044 0045 0064 0064 0061 0061 0061	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1	.0054 .005- .005- .005- .005- .003- .003- .003- .001- .001- .000- .000- .000- .000-	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .00000 .00000 .00000	113 097 084 075 005 024 000 000 000 000 000 000 000 000
1.40 1.60 1.77 2.00 4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632	-0126 -0111 -0100 -0087 -0023 0016 0025 0027 0029 0030 0031	1.257 1.060 1.009 1.009 1.010 1.3303 1.316 2.204 3.454 5.529 10.479 17.107 28.011	-0025 -0015 -0006 -0000 -0004 -0045 -0064 -0064 -0064 -0061 -0061	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1	.0054 .0054 .0054 .0054 .0034 .0034 .0034 .0034 .0014 .0004 .0004 .0004 .0004	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .00000 .00000	113 097 084 075 005 024 000 000 000 000 000 000 000 000
1.40 1.60 1.77 2.00 4.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 529	-0126 -0111 -0100 -0087 -0024 -0023 0025 0027 0029 0030 0031	1.257 1.060 1.009 1.009 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512	-0025 -0015 -0006 -0000 -0008 -0044 -0045 0064 0064 0061 0061 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5	.0051 .005- .005- .005- .004 .003- .003- .002 .001- .000- .000- .000	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317	.00519 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .00000 .00000 .00000	113 097 084 075 005 024 000 000 000 000 000 000 000 000
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 529 441	-0026 -0011 -0100 -0087 -0024 -0025 -0025 -0027 -0030 -0031 -0032 -0033 -0033 -0033	1.257 1.060 1.009 1.009 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512	-0025 -0015 -0006 -0000 -0008 -0044 -0045 0064 0064 0061 0061 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4	.0051 .005- .005- .005- .004 .003- .003- .002 .001- .000- .000- .000	1.6247 1.5642 1.5208 1.4702 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212	.0019 .00498 .00374 .00330 .00281 .00095 .00091 .00013 .00000 .00000 .00000 .00000 .00000 .00000	111 09 084 077 065 022 002 000 000 000 000 000 000 000
1.40 1.60 1.77 2.00 4.00 4.00 20.00 40.00 100.00 200.00 400.00 1000.00 200.00 400.00	2570 2519 2481 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 529 441	-0126 -0111 -0100 -0087 -0024 -0023 0016 0025 0027 0030 0031 0033 0033 0033	1.257 1.060 1.009 1.0009 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512	-0025 -0015 -0006 -0008 0044 0045 0064 0064 0064 0061 0061 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4	.0051 .0055 .0056 .0056 .0064 .0036 .0037 .0037 .0011 .0001 .0000 .0000 .0000 .0000 .0000	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .8733 .8469 .8317 .8212	.00219 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .00000 .00000 .00000 .00000 .00000	113 097 084 075 065 023 000 000 000 000 000 000
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 529 441	-0026 -0011 -0100 -0087 -0024 -0025 -0025 -0027 -0030 -0031 -0032 -0033 -0033 -0033	1.257 1.060 1.009 1.009 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512	-0025 -0015 -0006 -0000 -0008 -0044 -0045 0064 0064 0061 0061 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4	.0051 .005- .005- .005- .004 .003- .003- .002 .001- .000- .000- .000	1.6247 1.5642 1.5208 1.4702 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212	.00219 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .00000 .00000 .00000 .00000 .00000 .00000	113 094 077 084 077 025 022 000
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 4000.00	2570 2519 2481 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 942 441	-0126 -0111 -0100 -0087 -0024 -0025 -0027 -0029 -0030 -0032 -0039 -0039 -0039 -0039	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512	-0025 -0015 -0006 -0008 -0004 -0044 -0066 -0064 -0066 -0061 -0061 -0061 -0060 ENT FUEL	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4	.0051 .0055 .0056 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076 .0076	1.6247 1.5642 1.5208 1.4702 1.2289 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.9891 1.9891	.00219 .00438 .00374 .00330 .00281 .00091 .00001 .000000	113 097 098 007 006 002 006 000
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 1000.00 1000.00 1000.00	2570 2519 2481 2481 2484 2167 2159 1822 1581 1362 1109 942 796 632 529 441 2828 2811 2765	-0126 -0111 -0100 -0087 -0024 -0023 -0016 -0025 -0027 -0030 -0031 -0033 -0033 -0031 -00218 -0213 -0213	1.257 1.060 1.009 1.0009 1.010 1.303 1.316 2.204 3.454 5.522 10.479 17.107 28.011 53.887 88.516 145.512 0. PERC	-0025 -0015 -0006 -0000 -0008 0044 0064 0066 0061 0061 0060 0060 0060 0060 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 452.5 459.4 = 20.1	.005. .005. .005. .005. .007. .003. .002. .001. .001. .000. .000. .000. .000. .000. .000. .000.	1-6247 1-5642 1-5208 1-4702 1-2389 1-0871 1-0282 -9843 -9335 -9005 -8733 -8469 -8317 -8212 -9891 1-9138 1-9138 1-9138	.00219 .00438 .00374 .00330 .00281 .00095 .00091 .00002 .000000	113 094 077 084 077 025 022 000
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 529 441 2828 2811 2765 2711 2632	-0126 -0111 -0100 -0087 -0024 -0023 -0025 -0027 -0029 -0031 -0032 -0033 -0033 -0031 -0046 -0156	1.257 1.060 1.009 1.000 1.010 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512 2.147 1.251 1.057	-0025 -0015 -0006 -0000 -0008 -0045 -0045 -0064 -0062 -0061 -0061 -0061 -0060 -0060 -0060 -0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 410.8 430.1 444.1 452.5 459.4 49.2 94.7 124.0 150.6	.005. .005. .005. .005. .005. .004. .003. .002. .001. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000. .000.	1.6247 1.5642 1.508 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.4918 1.4918 1.4918 1.4918 1.4918 1.4918 1.4918 1.4918	.00219 .00438 .00374 .00330 .00281 .00091 .00001 .000000	- 113 - 094 - 077 - 084 - 077 - 024 - 002 - 000 -
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 200.00 400.00 200.00 1.00 200.00 1.00 1.00 1.00	2570 2519 2481 24367 2159 1822 1581 1362 1102 796 632 529 441 2828 2811 2765 2716	-0126 -0111 -0100 -0087 -0024 -0023 -0025 -0027 -0029 -0030 -0031 -0032 -0033 -0033 -0033 -0031 -0032 -0033 -0033	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 145.512 50. PERC 2.147 1.251 1.009 1.000 1.000	-0025 -0015 -0016 -0006 -0000 -0008 004 0064 0066 0061 0061 0061 0061 0061 0061 0061 0060 0064 0060 0060 0060 0060 0060 0060 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 446.1 452.5 459.4 = 20.1 124.0 150.6 164.2 181.4	.005. .005. .005. .005. .007. .003. .002. .001. .000.	1.66247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.6138 1.6247 1.7571 1.7571 1.7571	.00219 .00438 .00374 .00330 .00281 .00095 .00091 .000000	- 112 - 097 - 086 - 077 - 068 - 077 - 086 - 077 - 087 - 002 - 002 - 000 -
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 200.00 400.00 100.00 200.00 1.00 1.00 1.00 1.00	2570 2519 2481 24367 2159 1822 1582 1109 942 796 632 2828 2811 2624 2632 2711 2632 2711 2632 2735	-0126 -0111 -0100 -0087 -0024 -0023 -0025 -0027 -0029 -0030 -0031 -0032 -0033 -0033 -0038 -0181 -0186 -0	1.257 1.060 1.000 1.000 1.000 1.010 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512 2.147 1.251 1.057 1.000 1.000 1.012 1.317	-0025 -0015 -0006 -0000 -0008 -0045 -0044 -0064 -0064 -0066 -0061 -0061 -0061 -0060	96.0 129.6 152.4 16:-2 183.5 252.4 313.0 346.5 373.1 400.5 416.8 430.1 452.5 459.4 = 20.1	.005. .005. .005. .005. .004. .003. .002. .001. .000.	1.6247 1.5642 1.508 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .8069 .8733 .8469 .8317 .8212 2.0170 1.9891 1.0138 1.0287 1.7087 1.7771 1.7771 1.7771 1.7771 1.76426	.00219 .00438 .00374 .00330 .00281 .00091 .00001 .000000	113 097 084 077 085 024 000
1.40 1.50 1.77 2.00 4.00 4.00 4.00 20.00 40.00 20.00 40.00 40.00 100.00 200.00 400.00 1.00 4.00 1.00 1.00 1.00 1.	2570 2519 2481 2481 24367 2159 1822 1581 1362 1109 942 796 632 529 441 2828 2818 2716 2755 2711 2664 2664 2685	-0126 -0111 -0100 -0087 -0024 -0025 -0025 -0027 -0029 -0030 -0031 -0032 -0033 -0033 -0033 -0031 0018 0018 0018 0018 0018 0018 0018 0018	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 145.512 50. PERC 2.147 1.251 1.009 1.000 1.000	-0025 -0015 -0016 -0006 -0000 -0008 004 0064 0066 0061 0061 0061 0061 0061 0061 0061 0060 0064 0060 0060 0060 0060 0060 0060 0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 446.1 452.5 459.4 = 20.1 124.0 150.6 164.2 181.4	.005. .005. .005. .005. .007. .003. .002. .001. .000.	1.66247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.6138 1.6247 1.7571 1.7571 1.7571	.00219 .00438 .00374 .00330 .00281 .00095 .00091 .000000	113 097 084 077 085 024 000
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00 1.05 1.20 1.20 1.40 1.76 2.00 4.08	2570 2519 2481 24367 2159 1822 1581 1362 1109 942 796 632 529 441 2828 28165 2711 2634 2632 2535 2327	-0126 -0111 -0100 -0087 -0024 -002300150027002900300031003200330033003000310056005600560056	1.257 1.060 1.000 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512 2.147 1.057 1.057 1.008 1.000 1.012 1.331	-0025 -0015 -0006 -0000 -0008 -0045 -0044 -0045 -0061 -0061 -0061 -0061 -0061 -0061 -0061 -0060	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4 = 20.1 49.2 94.7 128.0 150.6 164.2 181.4 250.2 251.8	.00500500500500600300200100.	1.6247 1.5642 1.508 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .8069 .8733 .8469 .8317 .8212 2.0170 1.9891 1.0138 1.0287 1.7087 1.7771 1.7771 1.7771 1.7087 1.3326	.00219 .00438 .00374 .00330 .00281 .00091 .000000	- 112 - 097 - 098 - 077 - 086 - 077 - 006 - 002 - 002 - 000 -
1.40 1.50 1.77 2.00 4.00 4.00 4.00 20.00 40.00 20.00 40.00 100.00 2000.00 1.00 2000.00 1.00 1.	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 9426 529 441 2828 2828 2811 2705 2642 2632 2796	0.026 0.011 0.000 0.007 0.0024 0.00250027002900390039003900390039 0.0218	1.257 1.060 1.009 1.009 1.000 1.010 1.333 2.204 3.454 5.529 10.479 17.107 28.011 53.887 145.512 2.147 1.251 1.057 1.008 1.000 1.000 1.317 1.317 1.317	-0025 -0015 -0006 -0000 -0008 -0004 -0004 -0006	96.0 129.6 129.6 152.4 167.2 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4 = 20.1 150.6 150.6 150.6 251.8 311.3	.005. .005. .005. .005. .005. .003. .002. .001. .000.	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.9491 1.7771 1.7771 1.7771 1.7771 1.7491 1.7492 1.	.00219 .00438 .00374 .00330 .00281 .00091 .00002 .000000	
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00 1.05 1.20 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.4	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 942 796 632 529 441 2828 2811 2644 2632 2711 2644 2632 2711 2644 2711 2711 2711 2711 2711 2711 2711 27	-0126 -0111 -0100 -0087 -0024 -0025 -0027 -0029 -0030 -0031 -0032 -0031 -0032 -0031 -0032 -0031 -0042 -0052 -0	1.257 1.060 1.000 1.000 1.000 1.010 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 88.516 145.512 2.147 1.057 1.057 1.008 1.000 1.012 1.317 1.331 2.252	-0025 -0015 -0006 -0000 -0008 -0044 -0045 -0064 -0066 -0066 -0061 -0061 -0061 -0060 -0	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4 = 20.1 49.2 94.7 128.0 150.6 251.8	.00500500500500700.	1-6247 1-5642 1-5208 1-4702 1-2440 1-2389 1-0282 -9843 -9335 -9335 -8317 -8212 = 2-968 2-0170 1-9891 1-9138 1-6247 1-7571	00019 00438 00374 00330 00281 00095 00091 00002 000000	113 097 084 072 065 024 000
1.40 1.50 1.77 2.00 4.00 4.00 4.00 20.00 40.00 20.00 40.00 100.00 2000.00 1.00 2000.00 1.00 1.	2570 2519 2481 2434 2167 2159 1822 1581 1362 1109 9426 529 441 2828 2828 2811 2705 2642 2632 2796	0.026 0.011 0.000 0.007 0.0024 0.00250027002900390039003900390039 0.0218	1.257 1.060 1.009 1.009 1.000 1.010 1.333 2.204 3.454 5.529 10.479 17.107 28.011 53.887 145.512 2.147 1.251 1.057 1.008 1.000 1.000 1.317 1.317 1.317	-0025 -0015 -0006 -0000 -0008 -0004 -0004 -0006	96.0 129.6 129.6 152.4 167.2 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4 = 20.1 150.6 150.6 150.6 251.8 311.3	.005. .005. .005. .005. .005. .003. .002. .001. .000.	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.9491 1.7771 1.7771 1.7771 1.7771 1.7491 1.7492 1.	.00219 .00438 .00374 .00330 .00281 .00091 .00002 .000000	113 097 084 072 065 024 000
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00 1.	2570 2519 2481 2434 2167 2159 1822 11581 1362 1109 942 796 632 529 441 282 2811 2765 2711 2664 2632 2785 2732 2785 2785 2785 2785 2785 2785 2785 278	-0126 -0111 -0100 -0087 -0024 -002300160027002900300031003200390049	1.257 1.060 1.009 1.0009 1.010 1.303 1.316 2.204 3.454 5.529 17.107 28.011 53.887 18.516 145.512 50. PERC 1.057 1.007 1.317 1.331 2.252 5.719	-0025 -0015 -0006 -0000 -0008 0004 0064 0061	96.0 129.6 152.4 167.2 1283.5 252.4 254.0 313.0 346.5 373.1 400.5 400.1 444.1 452.5 459.4 - 20.1 49.2 94.7 128.0 150.6 164.2 181.4 250.2 251.8	.005005005005005007000.	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0282 .9843 .9335 .8317 .8317 .8212 1.917 1.918 1.917 1.918	00019 00434 00334 00281 00095 00091 00002 00000 00000 00000 00000 00000 00000 0000	- 113 - 097 - 086 - 077 - 068 - 077 - 068 - 077 - 086 - 002 - 000 - 000 - 000 - 000 - 000 - 000 - 000 - 191 - 151 - 144 - 122 - 051 - 051 - 051 - 000 -
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 1.00 1.00 1.00 1.00	2570 2519 2481 2434 2167 2159 1822 1109 942 776 632 529 441 2632 2583 2327 1996 1748 11518	-0126 -0111 -0100 -0087 -0024 -0023 -0025 -0027 -0029 -0031 -0032 -0031 -0032 -0031 -0032 -0031 -0042 -0043 -0181 -0186 -0	1.257 1.060 1.009 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 28.016 145.512 20.147 1.251 1.057 1.008 1.000 1.012 1.317 2.252 3.552 5.719 10.920	-0025 -0015 -0006 -0006 -0004 -0004 -0006	96.0 129.6 129.6 122.4 16:-2 2183.5 225.4 224.0 313.0 346.5 373.1 400.5 410.8 430.1 444.1 452.5 490.4 294.7 128.0 150.6 164.2 2251.8 311.3 345.4 372.6 400.8	.005. .005. .005. .005. .005. .004. .003. .002. .001. .000.	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0871 1.0282 .9843 .9335 .8033 .8469 .8317 .8212 2.0170 1.9891 1.7087 1.7087 1.6426 1.3401 1.3326 1.0332 1.0036 .9523 .9903	.00219 .00438 .00374 .00330 .00281 .00091 .000000	
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 100.00	2570 2519 2481 2434 2167 2159 1822 11581 1362 1109 942 796 632 529 441 282 2811 2765 2711 2644 2632 2785 2327 2327 2327 2441 2529 2785 2785 2785 2785 2785 2785 2785 2785	-0126 -0111 -0100 -0087 -0024 -0023 -0027 -0029 -0030 -0031 -0032 -0033 -0032 -0033 -0032 -0033 -0032 -0033 -0032 -0033 -0032 -0033 -0033 -0032 -0033 -0033 -0033 -0032 -0033 -0034 -0035 -0045 -0046 -0046 -0046	1.257 1.060 1.009 1.0009 1.010 1.303 1.316 2.204 3.454 5.529 17.107 28.011 53.887 18.516 145.512 50. PERC 1.057 1.007 1.317 1.331 2.252 5.719	-0025 -0015 -0006	96.0 129.6 152.4 167.2 1283.5 252.4 254.0 313.0 346.5 373.1 400.5 400.1 444.1 452.5 459.4 - 20.1 49.2 94.7 128.0 150.6 164.2 181.4 250.2 251.8	.005005005005005007000.	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0282 .9843 .9335 .8317 .8317 .8212 1.917 1.918 1.917 1.918	00019 00434 00334 00281 00095 00091 00002 00000 00000 00000 00000 00000 00000 0000	
1.40 1.60 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 1.00 1.00 1.00 1.00	2570 2519 2481 2434 2167 2159 1822 1109 942 776 632 529 441 2632 2583 2327 1996 1748 11518	-0126 -0111 -0100 -0087 -0024 -0023 -0012 -0012 -0039 -0049 -0059 -0062 -0062 -0064 -0064 -0068 -0069	1.257 1.060 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 18.516 145.512 50. PERC 1.057 1.007 1.031 1.057 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317 1.317	-0025 -0015 -0006 -0007 -0107 -0107 -0104 -0103	96.0 129.6 152.4 167.2 1283.5 252.4 254.0 313.0 346.5 373.1 400.5 416.8 430.1 444.1 452.5 459.4 = 20.1 49.2 94.7 128.0 150.6 251.8 311.3 345.4 372.6 400.8	.005005005005005005006007000 .000 .000 .000 .000 .	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.968 2.0170 1.9891 1.6247 1.7571 1.7571 1.7571 1.7573 1.6426 1.3326 1.0336 .9523 .9003 .8347	.00219 .00438 .00374 .00339 .00095 .00091 .00002 .000000	
1.40 1.50 1.77 2.00 4.08 10.00 20.00 40.00 100.00 200.00 400.00 100.00 200.00 1.05 1.20 1.40 1.76 2.00 4.00 4.00 1.76 2.00 4.00	2570 2519 2481 2434 2167 2159 1822 11581 1362 1109 942 796 632 529 441 282 2811 2765 2711 2644 2632 2785 2327 2327 2327 2441 2529 2785 2785 2785 2785 2785 2785 2785 2785	-0126 -0111 -0100 -0087 -0024 -0023 -0027 -0029 -0030 -0031 -0032 -0033 -0032 -0033 -0032 -0033 -0032 -0033 -0032 -0033 -0032 -0033 -0033 -0032 -0033 -0033 -0033 -0032 -0033 -0034 -0035 -0045 -0046 -0046 -0046	1.257 1.060 1.009 1.009 1.000 1.010 1.303 1.316 2.204 3.454 5.529 10.479 17.107 28.011 53.887 18.516 145.512 50. PERC 1.057 1.000 1.010 1.012 1.317	-0025 -0015 -0006	96.0 129.6 152.4 167.2 183.5 252.4 254.0 313.0 346.5 373.1 400.5 450.1 446.1 452.5 459.4 = 20.1 49.2 94.7 124.0 150.6 164.2 181.4 250.2 251.8 345.4 375.6 400.8 400.8	.005005005005005007000000 .000	1.6247 1.5642 1.5208 1.4702 1.2440 1.2389 1.0282 .9843 .9335 .9005 .8733 .8469 .8317 .8212 2.0170 1.9891 1.6247 1.7571 1.7571 1.7571 1.7571 1.7573 1.6426 1.3326 1.0336 .9523 .9003 .9523	.00219 .00438 .00374 .00339 .00281 .00095 .00091 .000000	

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equilibrium composition during isentropic expansion. Equivalence ratio, R; oxidant-fuel ratio, O/F.]

(a) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute

Pressure ratio,	Temp- erature, T,	Temp- erature exponent,	Area ratio,	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat,	(ð in M ð in P)	(dln m)
P _C /P	°K	n _T	ε	٦e	(lb)(sec)/lb	'nt	col/(gH°K)	(3)7	.(/p
	•	R = 0 • 6	SO. PERC	ENT FUEL	= 17.3	5. U/F	= 4.762		
	1						2 54/1	0.02196	-0.4374
1.00	3015	0.0304	2.131	0.0026	47.7	0.0108	2.5641	•02139	- 4278
1.20	2961	.0288	1.244	•0020	91.9	•0106	2.4522	.01985	4019
1.40	2914	.0274	1.054	•0012	124.2	•0103	2.3566	.01813	3722
1.60	2874	•0262	1.006	•0005	146.2	•0101	2.2736	.01668 .01582	3469
1.74	2849	+0254	1.000	*0000 *•0000	158 • 0 176 • 3	•0041 •0100	2.1350	.01439	3055
2 • 00 4 • 00	2595	.0165	1.339	0002	244.1	•0085	1.7214	.00832	1889
4.08	2588	.0162	1.354	0054	245.7	•0084	1.7099	•00816	1858
	2200	0063	2.346		305.5	•0067	1.2736	•00301	- •0756
10.00 20.00	2299	-0053	3.762	0120	340.5	•0054	1.0527	•00101	0278
40.00	1825	0064	6.136	0189	368 ⋅ 8	•0044	•9310	+00024	- •0074
								20003	0007
100.00	1529	0084	11.885	0195 0193	398.6 416.6	•0030 •0024	.8551 .8176	•00002 •00000	0001
200 • 00 400 • 00	1144	0093	32.844	0192	431.6	•0019	.7842	•00000	•0000
400.00	1	100/2	32.12.1						
1000.00	932	0098	64.475	0193	447.7	•0015	• 7449	•00000	•0000
2000.00	792	0101	107.316	0193	457.5	•0012 •0010	•7201 •7001	•00000	•0000
•000•00	670	0104	178.419	0194	403.0	•0010	•,001	-00000	
		R = C+	70. PERC	ENT FUEL	= 15.2	5. 0/F	= 5•556		
1 00	T2128	0.0363	Γ	Ī	I		3.1609	0.03650	-0.7110
1.00	3128	0.0362 .0358	2.122	0.0020	46.1	0.0126	3.1356	03584	701
1.20	3078	•0349	1.240	•0015	68.9	•0125	3.0046	•03406	6738
1.40	3037	. 0339	1.051	•0009	120.2	•0123	2.9793	•03201	641
1.60	3001	•0329	1.005	•0003	141.5	•0121	2.9028	•03026	- •613
1.73	2981	•0324	1.000	-•0000 -•0006	152.2	•0120 •0118	2.7698	•02927 •02738	565
2 • 00 4 • 00	2943 2761	•0313	1.015	0040	237.0	•0100	2.3262	.01894	415
4.08	2756	0254	1.369	0041	238.6	.0108	2.3126	.01870	410
4.00	12,70		1						
10.00	2517	.0160	2.414	0099	297.8	•0094	1.7290	+00970	2309
20.00	2320	•0071	3.943	0155	333.0	•0082 •0069	1.3390	•00478 •00183	0505
40.00	2108	0021	6.551	0215	362.1	•0007	1.0337	•00103	10,00
100.00	1813	0103	12.932	0265	395.3	-0053	.8583	•00031	- +0098
200.00	1596	0127	21.699	0276	412.5	• 0042	• 7942	•00005	- •0019
400.70	1395	0137	36.494	0277	428.6	•0034	.7553	•00001	- •0002
1000.00	1156	0146	72.660	0277	446.0	•0026	.7136	•00000	•0000
2000 • 00	996	0152	122.229	0279	456+8	•0022	•6848	•00000	•0000
4000+00	853	0158	205 • 254	0281	465.9	•0018	•6596	•00000	•0000
	-	R = 0.	an DEPC	ENT FUEL	= 13.6	0. O/F	= 6.349	•	•
	7		T PERC	1 7000	1300				0.0474
1.00	3188	0.0395	2 117	0.0014		0.0136	3.6135	0.05035	959
1.05	3175	.0392	2.117	.0.0016	86.0	0135	3.5527	-04808	937
1.20 1.40	3103	•0377	1.050	0007	116.3	0133	3.4973	.04616	911
1.60	3070	•0370	1.005	•0002	137.0	.0134	3 - 4 - 6 1	•04449	888
1.72	3052	.0366	1.000	•0000	147.0	•0131	3.4169	.04357	- 68748
2.00	3016	.0358	1.016	0005	165.3	•0130	3.3544	•04169	847
4.00	2853	•0317	1.361	0030	229.7	•0122 •0122	3.0181	•03300 •03275	7046
4.08	2848	•0316	1.370	40050	23116	-0	3-05.0	101111	
10.00	2645	.0252	2.453	0069	289.2	•0112	2.4611	•0∠178	5040
20.00	2487	.0188	4.050	0110	324.1	•0103	1.9810	•01399	- •343
40.00	2321	•0102	6.873	0166	353.4	•0093	1.2084	•00757	- •197
100.00	2074	0038	13.944	0261	385.5	•0078	1.0340	+00229	065
200.00	1868	0125	23.785	0319	405.7	•0065	.8417	•00065	- •020
400+00	1658	0170	40.475	0345	422.9	+0054	•7527	•00013	- 004
	1200	- 0101	81.660	0353	441.8	+0042	.6975	.00001	- •000
1000 • 00 2000 • 00	1398	0191 0201	138.794	0355	453.6	•0035	•6676	•00000	•000
4000.00	1058	0210	235.555	0358	463.7	•0029	•6395	•00000	• 0000
						0 1116	- 7 142	*	
		T- R = J.	90. PERC	ENT FUEL	. = 12•2	1	= /•143 		
	3213	0.0410			1		3.7588	0.02880	
1.05	3201	•040B	2.115	0.0014	43.2 83.2	0.0141	3.7501	•05827 •05683	-1.116
1.20	3168	•0401	1.238	•0010	112.6	خد د د م	2 466.3	•05515	-1.080
1.40	3131	•0394 •0388	1.005	•0003	132.7	-0137	3.6652	•05371	-1.063
1.72	3082	.0385	1.000	•0000	.142.2	.0136	3.6487	•05293	-1.053
2.00	3047	.0378	1.017	-•0004	160.2	.0134	3.6123	.05129	-1.033
	2892	.0146	1.364	0024	222.6	0128	3.4127	•04360	- 930
4.10	2888	•0345	1.379	-•on25	224.1	-0128	3 • 4059	.04358	926
4.70 4.58	2701	-0300	2.470	0053	280.5	•0120	3.0640	.03399	773
4.58		.0261	4.112	0077	314.7	.0110	2.7328	. 02668	640
4.58	2564		7.032	0107	343.6	•0107	2.3391	•01951	494
4.58		.0214	1.032					1	
4.58 10.00 20.00 40.00	2564 2429				9.74	A 40.71	1 7160	01057	ەنور. ـــ
10.00 20.00 40.00	2564 2429 2246	•0125	14.621	0166	375.8	•0097	1.7259	•01052 •00487	288
10.00 20.00 40.00 100.00 200.00	2564 2429 2246 2095	.0125 .0019	14.621 25.591	0241	396.6	•0088	1.2476	+00487	143
10.00 20.00 40.00	2564 2429 2246 2095	•0125	14.621 25.591 44.582		396.6		1.2476	+00487 +00150	- •143
4.58 10.00 20.00 40.00 100.00 200.00 400.00	2564 2429 2246 2095 1919 1660	.0125 .0019 0112	14.621 25.591 44.582 91.675	0241 0335 0406	396.6 414.7 435.1	•0088 •0077 •006∠	1.2476	.00487 .00150	047
4.58 10.00 20.00 40.00 100.00 200.00 400.00	2564 2429 2246 2095 1919 1660	.0125 .0019 0112	14.621 25.591 44.582	-•0241 -•0335	396.6 414.7	•0088 •0077	1.2476	.00487 .00150	143 047 006 001

TABLE III. - Continued. THERMODYNAMIC DERITATIVES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equilibrium composition during isentropic expansion. Equivalence ratio, R; oxidant-fuel ratio, 0/F.]

(a) Continued. Combustion-chamber pressure, 60 pounds per square inch absolute

Pressure ratio, P _C /P	Temp- erature, T, °K	Temp- erature exponent,	Area ratio, E	Area- ratia exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat, col/(g)(°K)	(3 ln 97) _T	(ð in 977 (ð in T
		''T		°e	(lb)(sec)/lb	n _I	col/(g)(°K)	<u> </u>	<u> </u>
		R = 1.	00. PERC	ENT FUEL	= 11.1	9. O/F	- 7.937		
1.00	3217	0.0412					3.6327	0.06081	-1.160
1.05	3205	+0410	2.115	0.0014	41.9	0.0141	3.6262	•06031	-1.155
1.20	3173	•0404 •0397	1.050	•0010	80 · 8 109 • 3	•0140 •0138	3.6075 3.5839	•05894 •05736	-1.140
1.40	3104	•0391	1.005	•0002	128.7		3.5618	.05599	-1.108
1.72	3088	•0388	1.000	•0000	137.9	•0136	3.5493	05526	-1-099
2.00	3053	•0382	1.017	0004	155.4		3.5214	•05371	-1.081
4.00 4.08	2900 2896	•0351 •0350	1.364	0023	216.0	•0129 •0129	3.3683 3.3631	.04671 .04650	990
4.00	2070	•0350	1.500	10027	21,00	•0127	3.3031	104030	.,,,,
10.00	2713	•0310	2.474	0049	272.3	+0121	3.1047	.03772	855
20.00 40.00	2579 2452	•0277 •0242	4 • 124 7 • 068	0070	305.6 333.7	•0115 •0109	2.8627	+03120 +02502	744
40.00	2432	.0242	1.000	•0072	33301	•010		*02502	1020
100.00	2287	+0187	14.785	0127	365.2	•0101	2.1850	•01751	472
200.00	2164	.0137	26.152	0160	385.7	•0095	1.8612	-01248	247
400.00	2037	•0075	46.510	0202	403.9	•0089	1.0000	•00816	- 1241
1000 • 00	1859	0030	99.697	0277	424.9	•0079	1.1390	+00380	126
2000.00	1710	0127	176.636	0348	438+8	•0070	· 8974	•00170	061
4000.00	1549	0219	310.311	0417	451.0	•0061	•7318	•00058	023
		R = 1.	50, PERC	ENT FUEL	= 7.7	4. O/F	1.905		
1.00	3116	0.0362					2 • 2973	0.03957	-0.794
1.05	3103	•0359	2.117	0.0016	37.2	0.0126	2.2869	.03905 .03763	- •787
1.20	3070	.0352 .0344	1.238	+0012	71.6 96.8	•0125 •0123	2.2574	.03/63	767
1.60	2999	0336	1.005	•0002	114.1	•0122	2.1892	+03461	723
1.72	2981	.0332	1.000	•0000	122.4	•0121	2.1710	.03385	712
2 • 00	2945	•0324	1.016	-•0005	137.7	•0120	2.1323	•03230 •02538	686
4 • 00 4 • 08	2782	.0284 .0282	1.361	0029	191.3	•0112 •0112	1.9340	.02518	571
				10000					
10.00	2576	•0223	2.454	0065	240.8	+0102	1.6300	-01698	419
20.00 40.00	2421	.0168 .0102	4 • 065 6 • 896	-•0099 -•0141	270.0	•0094 •0086	1.3799	+01144 +00685	196
40.00	2203	10102	0.070	10171	.,,,,,	.0000		10000	****
100.00	2040	0003	14.098	0212	321.3	•0073	.8344	•00264	086
200.00	1856	0082	24.259	0267	338 - 4	•0063	•6739 •5774	+00096	035
400+00	1664	0139	41.606	0306	353.1	•0053	.5174	•00026	011
1000.00	1415	0175	84.484	0326	369.3	-004 1	.5156	-00003	- •001
2000 • 00	1240	0187	144.082	0331	379.5	•0034	•4898	•00000	000
4000+00	1080	0196	245.360	0334	388.2	•0029	•4690	•00000	•000
		R = 2+1	DO. PERC	ENT FUEL	* 5.9	2. O/F	5-873		
1.00	2966	0.0297					1.5209	0.02254	-0.487
1.05	2953	•0294	2.122	0.0019	34-1	0.0107	1.5098	+02210	480
1.20	2917	.0285 .0275	1.240 1.052	•0014	65.7 88.8	•0106 •0104	1.4788	•02091 •01957	460
1.40 1.60	2877 2841	•0266	1.002	•0008 •0003	104.6	•0102	1.4091	-01842	417
1.73	2821	•0260	1.000	•0000	112.6	-0101	1.3901	-01778	406
2.00	2783	.0250	1.015	0006	126.3	•0099	1.3529	.01657	384
4.00	2604	•0197	1.353	0037	175.2	•0090	1.1688	+01130	283
4.08	2599	•0196	1.368	0038	1/044	•0090	1.1632	+01116	- +200
10.00	2365	.0117	2.412	0087	220+1	•0078	•9205	-00575	161
20.00	2177	•0048	3.941 6.557	0131	246-1	•0067	• 7501	•00286	089
40.00	1978	0019	6.557	0175	267.6	•0056	•6166	+00114	- •040
100.00	1706	0080	12.980	0214	296.7	د 0044	•5100	•00022	- •009
200.00	1505	0102	21.822	0224	305.0	•0035	•4699	+00005	- +002
400•10	1318	0111	36.754	0227	316.9	•0029	• 4457	•00001	- •000
1000.00	1095	0118	73.335	0227	329.9	•0022	.4221	•00000	•000
2000.00	945	0123	123.637	0228	338.0	•0018	•4064	•00000	•000
+000 • 00	812	0128	208.163	0230	344.8	•0015	•3916	•00000	•000
		R = 3+0	DO PERCI	ENT FUEL	= 4.0	3. O/F	3.810		
1.00	2655	0.0175					0.8140	0+00697	-0.176
1 • 05	2640	+0171	2 • 140	0.0026	30 • 2 58 • 1	0.0067 .0065	•8048 •7795	•00672 •00604	- •170 - •156
1.20 1.40	2599	•0160 •0147	1.248	•0019 •0011	78.5	•0063	•7506	+00531	156
1.60	2509	0135	1.007	•0005	92.3	•0061	.7260	+00472	127
1.75	2481	•0127	1.000	•0000	100.3	•0059	•7099	+00435	- +119
2 • 0 0 4 • 0 0	2438	•0116 •0057	1.013 1.325	0007 0043	111.3 153.7	•0057 •0046	.6858 .5739	•00382 •00175	- •107 - •055
4 • 08	2216	•0055	1.339	0044	154.8	•0045	•5710	•00170	- •053
10.00	1915	0002	2.286	0079	191.7	•0032	•4712	•00044	016
20.00	1691	0026	3.629 5.877	-•0092 -•0095	213.1	•0024 •0019	•4277 •4030	•00011	- •005
40.00	1480	0036	2.011	-0077	->0*2	-0017	030	•00002	2001
100.00	1229	0040	11.319	0093	248-1	•0013	•3820	•00000	- •000
200.00	1061	0042	18+732	0092	258.9	•0011	• 3686	• 00000	•000
400•00	911	-•0043	31.103	-•0092	267.9	•0009	-3561	•00000	•000
	739	0045	60.907	0092	277.4	•0006	•3403	• 00000	•000
1000•00									
1000•00 2000•00	627 529	0047	101.211	0092	283.3	•0005 •0004	•3295 •3198	•00000	•000

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equilibrium composition during isentropic expansion. Equivalence ratio, R; oxidant-fuel ratio, $0/\text{F.}\xspace$

(a) Concluded. Combustion-chamber pressure, 60 pounds per square inch absolute

	°K	exponent,	ratio, E	exponent,	impulse, I, (b)(sec)/b	impulse exponent, ⁿ I	heat, c _p , cal/(g)(°K)	(3 in 92),	(ðin T)
		R = 4.1	OO. PERC	ENT FUEL	= 3.0	5. 0/F	= 1.746		
1.00	2347	0.0079					0.5285	0.00185	-0.055
1.05	2330	•0075	2.165	0.0021	27.4	0.0032	•5227	•00175	- •052
1.20 1.40	2282	•0066 •0056	1.260 1.061	•0015	52 • 7 71 • 2	•0030 •0028	•5073 •4906	•00147 •00120	045
1.60	2180	-0047	1.009	+0004	83.6	+0026	•4772	•00099	- +032
1.78 2.00	2143	•0041 •0034	1.000 1.009	0004	92.1	•0024 •0023	•4674 •4569	.00085 .00071	028
4.00 4.08	1858 1851	•0006 •0006	1.297	0021 0021	138+3	•0016 •0016	•4102 •4092	•00021 •00020	- •008
10.10 20.30 40.00	1556 1351 1167	0008 0011 0012	2.192 3.439 5.518	-•0027 -•0027 -•0027	171.3 189.6 204.1	•0010 •0007 •0005	•3769 •3619 •3501	•00003 •00000 •00000	- •001 - •000
100.00 200.00 400.00	954 815 692	0013 0013 0014	10.507 17.236 28.358	-•0026 -•0025 -•0025	219:1 228:0 235:4	•0004 •0003 •0002	•3354 •3244 •3141	•00000 •00000	•000 •000
000.00	553 464	-•0014 -•0015	54•842 90•278	-•0025 -•0025	243•2 247•9	•0002 •0001	•3013 •2929	•00000	•000
•000•00	387	0015	148.471	0025	= 2.4	•0001	•2865 = 9•683	•00000	•0000
	T	R = 5 • (JU) PERC	ENT FUEL	- 2.4	J, J,F			T=0 =15
1.00 1.05	2062	0+0027 +0025	2.186	0.0010	25.2	0.0011	0.4109 .4079	0.00043 -00040	-0.015
1.20	1995	•0020	1.269	•0007	48.4	•0010	•4004	•00032 •00024	011
1.40 1.60	1938	+0016	1.066 1.011	•0004 •0002	65.3 76.7	•0009 •0008	•3925 •3864	•00024	009
1.80	1849	•0010	1.000	•0000	95 • 1 92 • 2	•0008	•3816 •3775	•00015 •00012	005
2 • 00 4 • 00 4 • 08	1811 1578 1571	+0008 +0000 +0000	1.282 1.295	0001 0005 0005	126.2	•0004 •0004	•3579 •3575	•00002 •00002	001
10.00 20.00 40.00	1304 1122 961	0003 0003 0003	2.145 3.345 5.334	-•0006 -•0006 -•0005	155.7 171.9 184.7	•0002 •0002 •0001	•3413 •3309 •3209	•00000 •00000	- •000 •000
100.00 200.00 400.00	778 659 555	0003 0004 0003	10.072 16.410 26.810	-•0005 -•0005 -•0005	197:8 205:6 212:0	.0001 .0001	•3076 •2979 •28 8 8	•00000 •00000	•000
000.00	438 365 303	0004 0004 0004	51.370 84.029 137.526	0005 0005 0005	21E+6 222+6 225+9	•0000 •0000	•2783 •2728 •2693	•00000 •00000	•000

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

[Equilibrium composition during isentropic expansion. Equivalence ratio, R; oxidant-fuel ratio, $\mbox{O/F.}\mbox{]}$

(b) Combustion-chamber pressure, 150 pound3 per square inch absolute

P _c /P	Temp- erature, T, °K	Temp- erature exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse, I.	Specific- impulse expunent,	Specific heat, Cp, col/(g)(°K)	(<u>ð In 10</u> 1, ∂ In P) ₇	(ð la 97) (ð la T)
		n _T		ne.	(lb)(sec)/lb	<u> </u>	l		
		R = 0.	15, PERC	ENT FUEL	= 45.6	5. J/F	= 1.190		
1.00	1183	0.0000					1.7752	0.00000	0.000
1.05	1168	•0000	2 • 250	0.0000	47.4	0.0000	1.7711	•00000	•000
1 • 20 1 • 40	1129	•0000 •0000	1.297	•0000	90 · B	•0000	1.7473	•00000	•000
1.60	1049	•0000	1.018	•0000	143.2	•0000	1.7368	•00000	•000
1.87	1008	•0000	1.000	•0000	163.4	• ODOO	1.7257	•00000	•000
2 • 00	989	•0000	1.003	•0000	232.3	•0000	1.7210	•00000	•000
4 • 00	824	•0000	1.233	•0000	232.3	•0000	1.005	•00000	****
10:00	643	•0000	1.974	•0000	283-1	•0000	1 - 65 05	•00000	•000
10.21	639	•0000	1.997	•0000	284+0	• 0:100	1.6501	•00000	•000
20 • 00 40 • 00	532 439	•0000	2+982 4+620	•0000	309.9	•0100	1.6343	•00000 •00000	•000
40400	7,7	***************************************		-0000					
100:00	340	•0000	8 • 4 3 2	-0000	350-8	•0100	1.6091	•00000	•000
200 • 00 400 • 20	280 230	•0000	13.431	•0000	362 • 6 372 • 0	•0100	1.5971	•00000	•000
400170	230	•0000	210400	•0000	3,200	•0.00	102330	-00000	1000
1000•00	175	•0000	39.928	•0000	381.6	•0100	1.4845	•00000	•000
2000•00	142	•0000	63-572	•0000	387 • 2	+0000	1.4387	•00000	+000
4000-00	114	•0000	100+938	•0000	391.6	•0100	1.4054	•00000	•000
		R = 0.	20. PERC	ENT FUEL	= 38.6	5. 0/F	= 1.587		T
1:00	1514	0.0000					1.6191	0.00000	-0.000
1.05	1497	•0000	2 • 233	0.0000	49.3	0.0000	1.6146	•00000	•000
1 • 20 1 • 40	1450 1398	•0000	1.289	•0000	127.4	•0000 •0000	1.5889	•00000 •00000	•000
1.60	1354	•0000	1.016	•0000	149.4	•0300	1.5773	•00000	•000
1.85	1307	•0000	1.000	•0000	169-2	• 0 100	1.5652	•00000	•000
2 • 00	1282	•0000	1-004	•0000	179+1	•0100	1.5585	•00000	• 000
4.00	1079	•0000	1.244	*0000	243+2	•0100	1.5045	•00000	•000
10.00	852	•0000	2+009	•0000	297.2	•0100	1.4516	•00000	•0000
10.21	847	•0000	2.033	+0000	298 • 2	•0)00	1.4506	•00000	•000
20.00	709	•0000	3.049	•0000	325+9	•0)00	1.4232	•00000	•000
40.00	588	•0000	4.739	•0000	340.0	-0300	1.400	•00000	- 5000
100.00	458	+0000	8 • 6 7 9	•0000	370.0	• 0-)00	1.3914	•00000	• 000
200+00	379	•0000	13-870	•0000	382 • 7	•0000	1.3807	•00000	-000
400 • 70	312	•0000	22-295	•0000	393-0	•0000	1.3677	•00000	•000
1000+00	242	•0000	41.979	•0000	403.5	•0200	1.3402	-00000	• 0000
2000 • 00	198	•0000	67-687	•0000	409 • 7	•0)00	1 - 2958	•00000	•000
4000+00	161	•0000	108.754	•0000	414.6	•0)00	1.2580	•00000	•000
		R = 0.	25. PERC	ENT FUEL	= 33.5	1.)/F	= 1.984		
	T			1					T
1.00	1816	0+0002					1-5040	0.00003	
1.05	1797	•0002	2.218	0.0001	50.3	0.0101	1.4992	•00002	000
1.05 1.20	1797 1745	•0002 •0001	1.283	•0001	96 • 6	•0)01	1.4992	•00002 •00002	000
1.05 1.20 1.40	1797	•0002 •0001 •0001					1.4992	•00002	000 000
1.05 1.20 1.40 1.60 1.83	1797 1745 1686 1636 1587	•0002 •0001 •0001 •0000	1.283 1.073 1.015 1.000	•0000 •0000	96.6 130.1 152.7 171.8	•0301 •0301 •0300 •0300	1.4992 1.4867 1.4730 1.4616 1.4503	.00002 .00002 .00001 .00001	000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00	1797 1745 1686 1636 1587 1555	•0002 •0001 •0001 •0000 •0000	1.283 1.073 1.015 1.000 1.005	•0000 •0000 •0000	96.6 130.1 152.7 171.8 183.1	•0301 •0301 •0300 •0300	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429	.00002 .00002 .00001 .00001 .00000	000 000 000 000
1.05 1.20 1.40 1.60 1.83	1797 1745 1686 1636 1587	•0002 •0001 •0001 •0000	1.283 1.073 1.015 1.000	•0000 •0000	96.6 130.1 152.7 171.8	•0301 •0301 •0300 •0300	1.4992 1.4867 1.4730 1.4616 1.4503	.00002 .00002 .00001 .00001	000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.20	1797 1745 1686 1636 1587 1555 1322	.0002 .0001 .0001 .0000 .0000 .0000	1.283 1.073 1.015 1.000 1.005 1.256	.0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3	•0101 •0101 •0100 •0100 •0100 •0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875	.00002 .00002 .00001 .00001 .00000 .00000	000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.90	1797 1745 1686 1636 1587 1555 1322 1057 1052	.0002 .0001 .0001 .0000 .0000 .0000	1.283 1.073 1.015 1.005 1.256 2.048 2.073	.0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3	•0101 •0101 •0100 •0100 •0100 •0100 •0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875	.00002 .00002 .00001 .00001 .00000 .00000	000 000 000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.90 10.00 10.21 20.00	1797 1745 1686 1636 1587 1555 1322 1057 1052 887	.0002 .0001 .0001 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.000 1.005 1.256 2.048 2.073 3.127	.0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 306.6 335.7	•0001 •0001 •0000 •0000 •0000 •0000 •0000 •0000 •0000	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847	.00002 .00002 .00001 .00000 .00000 .00000	000 000 000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.90	1797 1745 1686 1636 1587 1555 1322 1057 1052	.0002 .0001 .0001 .0000 .0000 .0000	1.283 1.073 1.015 1.005 1.256 2.048 2.073	.0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3	•0101 •0101 •0100 •0100 •0100 •0100 •0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875	.00002 .00002 .00001 .00001 .00000 .00000	000 000 000 000 000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.20 10.00 10.21 20.00 40.00	1797 1745 1686 1636 1587 1555 1322 1057 1057 741 581	.0002 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.000 1.005 1.256 2.048 2.073 3.127 4.883 8.985	.0001 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 305.6 335.7 359.0	.0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.70 10.00 10.21 20.00 40.00	1797 1745 1686 1636 1587 1555 1322 1057 1052 897 741 581 482	.0002 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.000 1.005 1.256 2.073 3.127 4.883 8.985 14.396	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 306.6 335.7 359.0 382.4 395.9	-0.001 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3213 1.3213 1.3213 1.2559	.00002 .00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.20 10.00 10.21 20.00 40.00	1797 1745 1686 1636 1587 1555 1322 1057 1057 741 581	.0002 .0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.000 1.005 1.256 2.048 2.073 3.127 4.883	.0001 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 305.6 335.7 359.0	.0001 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000	-0.000'000'000'000'000'000'000'000'000'000'000'000'000'000'000'000'000'
1.05 1.20 1.40 1.60 1.83 2.00 4.20 10.00 10.21 20.00 40.00	1797 1745 1686 1636 1587 1555 1322 1057 1052 887 741 581 482 399	.0002 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.005 1.005 1.256 2.073 3.127 4.883 8.985 14.396 23.208	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 306.6 335.7 359.0 382.4 395.9 406.8	-0.001 -0.001 -0.0000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.0000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.0000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.0000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.0000 -0.0	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3213 1.2847 1.2559 1.2320 1.2190 1.2100	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00	1797 1745 1686 1636 1587 1555 1357 1057 1057 1057 741 581 482 399	.0002 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.005 1.005 1.256 2.073 3.127 4.883 8.985 14.396 23.208	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 305.6 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7	-0.001 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2190 1.2190 1.1953 1.1803	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00	1797 1745 1686 1636 1587 1555 1357 1057 1057 1057 741 581 482 399	.0002 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	1.283 1.073 1.015 1.005 1.005 1.256 2.073 3.127 4.883 8.985 14.396 23.208 43.894 71.280	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2	-0.001 -0.001 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000	1.4992 1.4873 1.4730 1.4616 1.4503 1.4429 1.3875 1.3213 1.2847 1.2559 1.2290 1.2190 1.1953 1.1803 1.1481	.00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00	1797 1745 1686 1636 1587 1355 1322 1057 1057 741 581 482 399 310 256	-0002 -0001 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000	1.283 1.073 1.015 1.005 1.005 1.256 2.073 3.127 4.883 8.985 14.396 23.208 43.894 71.280	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2	-0.001 -0.001 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000 -0.000	1.4992 1.4873 1.4730 1.4616 1.4503 1.4429 1.3875 1.3213 1.2847 1.2559 1.2190 1.2190 1.1953 1.1481 2.381	.00002 .00002 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 -
1.05 1.20 1.40 1.60 1.83 2.00 4.90 10.21 20.00 40.00 100.00 200.00 40.00	1797 1745 1686 1636 1587 1555 1322 1057 1052 807 741 501 402 399 310 256 210	-0002 -0001 -0001 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000	1.283 1.073 1.073 1.073 1.005 1.005 1.256 2.073 3.127 4.883 8.985 23.208 43.894 471.280 115.651	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 306.6 335.7 359.0 382.4 406.8 418.1 424.7 430.2 = 29.5	-0.001 -0.001 -0.000 -0.1000 -	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3213 1.2847 1.2559 1.2559 1.2190 1.2190 1.1953 1.1481 2.381	.00002 .00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00 100.00 200.00	1797 1745 1686 1636 1587 1555 1322 1057 1057 741 581 482 399 310 256 210	.0002 .0001 .0000	1.283 1.073 1.015 1.005 1.005 1.256 2.048 2.048 2.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 143.1 1249.3 305.6 306.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2	-0101 -0101 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2320 1.2190 1.2190 1.1953 1.1803 1.1481 2.381 1.4388 1.4388	.00002 .00002 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000 000 000 000 000 000 .000
1.05 1.20 1.40 1.60 1.83 2.00 4.90 10.21 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00	1797 1745 1686 1636 1587 1555 1322 1057 1057 1057 1057 1057 1057 1057 1057	.0002 .0001 .0000	1.283 1.073 1.073 1.073 1.005 1.005 1.256 2.073 3.127 4.883 8.985 23.208 43.894 471.280 115.651	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 306.6 335.7 359.0 382.4 406.8 418.1 424.7 430.2 = 29.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3213 1.2847 1.2559 1.2559 1.2190 1.2190 1.1953 1.1481 2.381	.00002 .00002 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00 100.00 200.00	1797 1745 1686 1636 1587 1555 1322 1057 1057 741 581 482 399 310 256 210	.0002 .0001 .0000	1.283 1.073 1.073 1.073 1.005 1.005 1.256 2.073 3.127 4.883 8.985 14.396 23.208 43.894 71.280 115.651 30, PERC	.0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	96.6 130.1 152.7 171.8 183.1 1249.3 305.6 305.6 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2 = 29.5	-0101 -0101 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100 -0100	1.4992 1.4867 1.4730 1.4018 1.403 1.4429 1.3873 1.3225 1.3225 1.3231 1.2847 1.2559 1.2190 1.2190 1.1903 1.1803 1.1803 1.1434 1.4282 1.411 1.3786	-00002 -00001 -00001 -000000	000 -
1.05 1.20 1.40 1.40 1.60 1.83 2.00 4.70 10.00 10.21 20.00 40.00 200.00 200.00 400.00 100.00 200.00 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.05 1.05 1.05 1.05 1.05 1.05 1.0	1797 1745 1686 16367 1555 1322 1057 741 581 482 399 310 2210	.0002 .0001 .0000	1.283 1.073 1.015 1.000 1.005 1.256 2.073 3.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651 1.277 1.070	.0001 .0000	96.6 130.1 152.7 171.8 183.1 1249.3 305.6 335.7 359.0 382.4 9406.8 418.1 424.7 430.2 = 29.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2190 1.2190 1.1803 1.1481 1.4482 1.4411 1.3931 1.3786 1.3786	-00002 -00001 -00001 -00001 -000000	000 000
1.05 1.20 1.40 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00 100.00 200.00 400.00	1797 1745 1686 16367 1555 1322 1057 741 581 489 310 256 210 2092 2071 2015 1491 1497 1846 1809	.0002 .0001 .0000	1.283 1.073 1.073 1.075 1.005 1.256 2.048 2.073 3.127 4.883 14.396 23.208 43.898 115.651 30. PERC 1.277 1.070 1.013 1.000	.0001 .0000	96.6 130.1 152.7 171.6 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 418.1 424.7 430.2 = 29.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2859 1.2559 1.2559 1.2190 1.2100 1.1953 1.1481 1.4348 1.4282 1.4111 1.3781 1.3786 1.3659 1.35659	.00002 .00002 .00001 .000000	
1.05 1.20 1.40 1.40 1.60 1.83 2.00 4.70 10.00 10.21 20.00 40.00 200.00 200.00 400.00 100.00 200.00 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.20 1.05 1.05 1.05 1.05 1.05 1.05 1.05 1.0	1797 1745 1686 16367 1555 1322 1057 741 581 482 399 310 2210	.0002 .0001 .0000	1.283 1.073 1.015 1.000 1.005 1.256 2.073 3.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651 1.277 1.070	.0001 .0000	96.6 130.1 152.7 171.6 183.1 249.3 305.6 335.7 359.0 382.4 399.9 406.8 418.1 424.7 430.2 = 29.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2190 1.2190 1.1803 1.1481 1.4482 1.4411 1.3931 1.3786 1.3786	-00002 -00001 -00001 -00001 -000000	000 000
1.05 1.20 1.40 1.60 1.60 1.63 2.00 4.70 10.00 10.21 20.00 40.00 40.00 40.00 100.00 200.00 400.00 1.00 400.00 1.00 1.00 1.00	1797 1745 1686 1636 1587 1322 1057 1057 741 581 2399 310 2560 22071 2210 2271 1846 1863 1258	.0002 .0001 .0000	1.283 1.073 1.073 1.073 1.005 1.256 2.078 2.127 4.883 8.985 14.396 23.208 43.894 71.280 115.651 30, PERC 2.205 1.277 1.070 1.013 1.000	-0001 -0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 406.8 418.1 424.7 430.2 = 29.5 50.6 151.4 154.2 172.6 185.1 252.5 310.4	-0101 -0101 -0100	1.4992 1.4867 1.4663 1.4613 1.4623 1.4429 1.3875 1.3225 1.3225 1.22559 1.2320 1.2190 1.1803 1.1803 1.1481 1.44348 1.4282 1.411 1.3786 1.3659 1.3567 1.2937		000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.90 10.20 20.00 40.00 10.20 10.00 200.00 400.00 100.00 200.00 1.00 1.00 1.00 1.00	1797 1745 1686 1636 1636 1555 1057 1052 1057 1052 887 7741 581 482 2071 2015 210 256 210	-0002 -0001 -0000	1.283 1.073 1.015 1.005 1.005 1.256 2.048 2.073 3.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651 30, PERC	.0001 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 424.7 430.2 = 29.5 50.8 97.5 131.4 125.1 252.5 310.6	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2190 1.2190 1.2190 1.1953 1.1803 1.1481 2.4411 1.3931 1.3786 1.3657 1.3786 1.3657 1.2999 1.2999	0.0002 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000	
1.05 1.20 1.40 1.60 1.60 1.00 10.00 10.21 20.00 40.00 100.00 200.00 400.00 1.00 400.00 1.00 1.00 1.00	1797 1745 1686 1636 1587 1057 1052 1057 741 581 482 399 310 256 210 207 2071 1897 1897 1897 1897 1897 1897 1897 18	.0002 .0001 .0000	1.283 1.073 1.073 1.073 1.073 1.073 1.276 2.073 3.127 4.863 14.396 23.208 43.894 71.280 15.651 30, PERC 2.073 1.073 1.000 1.266	-0001 -0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 359.0 406.8 418.1 424.7 430.2 = 29.5 50.8 97.5 131.4 154.2 172.6 185.1 252.5	-0101 -0101 -0100	1.4992 1.4867 1.4663 1.46163 1.4429 1.3875 1.3225 1.3223 1.2847 1.2559 1.2320 1.2190 1.2190 1.2190 1.1953 1.1803 1.1481 1.44348 1.4282 1.4111 1.3786 1.3659 1.3659 1.2997		000 000
1.05 1.20 1.40 1.60 1.83 2.00 4.90 10.20 20.00 40.00 10.20 10.00 200.00 400.00 100.00 200.00 1.00 1.00 1.00 1.00	1797 1745 1686 1636 1636 1555 1057 1052 1057 1052 887 7741 581 482 2071 2015 210 256 210	-0002 -0001 -0000	1.283 1.073 1.015 1.005 1.005 1.256 2.048 2.073 3.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651 30, PERC	.0001 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 424.7 430.2 = 29.5 50.8 97.5 131.4 125.1 252.5 310.6	-0101 -0101 -0100	1.4992 1.4867 1.4663 1.4663 1.4429 1.3875 1.3225 1.3225 1.3232 1.2847 1.2559 1.2190 1.2190 1.1953 1.1803 1.1803 1.1481 1.4348 1.4282 1.411 1.3786 1.3659 1.3567 1.2999 1.2397 1.2999 1.2337 1.2999 1.2337 1.2	0.0002 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000	000 000
1.05 1.20 1.40 1.60 1.60 1.00 10.00 10.21 20.00 40.00 100.00 200.00 400.00 1.00 400.00 1.00 1.00 1.00	1797 1745 1686 1636 11587 11557 1057 1057 741 581 482 2071 2015 2010 2011 2015 2011 2015 2011 2015 2011 2015 2011 2015 2011 2015 2017 2015 2017 2015 2017 2015 2017 2015 2017 2015 2017 2015 2017 2017 2017 2017 2017 2017 2017 2017	-0002 -0001 -0000	1.283 1.073 1.015 1.005 1.005 1.256 2.043 3.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651 2.005 1.277 1.070 1.006 1.206 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.209	.0001 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 406.8 424.7 430.2 = 29.5 50.8 97.5 131.4 151.2 172.6 185.1 252.5 341.7 366.0 390.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2190 1.2190 1.2190 1.2190 1.1803 1.1481 1.4438 1.4411 1.3931 1.3786 1.3657 1.2999 1.2990 1.2190 1.2190 1.3931 1.3786 1.3657 1.2999 1.2937 1.2932 1.2937 1.2932 1.2937 1.2932 1.1931	0.0002 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000	000 000
1.05 1.20 1.40 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.00 1.00 1.00 1.20 1.40 1.40 1.82 2.00 4.00 1.82 2.00 4.00 1.82 2.00 4.00 1.82 2.00 4.00 1.82 2.00 4.00 4.00 1.00 1.00 1.00 1.00 1.00 1	1797 1745 1686 1636 1636 1636 1322 1057 1052 2072 2072 2072 2071 1897 1897 1897 1897 1897 1897 1897 18	.0002 .0001 .0000	1.283 1.073 1.015 1.005 1.256 2.048 2.073 3.127 4.883 8.985 14.396 23.208 43.894 71.280 115.651 30. PERC 2.205 1.277 1.073 1.000 1.266 2.085 2.011 2.005 2.011 2.0		96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 418.7 430.2 = 29.5 50.6 97.5 151.4 152.5 310.4 311.5 341.7 366.0 390.5 400.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4063 1.4429 1.3875 1.3225 1.3225 1.2847 1.2559 1.2100 1.1953 1.1803 1.438 1.438 1.438 1.438 1.438 1.438 1.4393 1.4399 1.2599		000 000
1.05 1.20 1.20 1.40 1.60 1.63 2.00 4.00 10.21 20.00 40.00 10.00 200.00 400.00 1.05 1.20 1.05 1.20 1.40 1.62 1.40 1.62 1.62 1.62 1.62 1.63 1.63 1.63 1.63 1.63 1.63 1.63 1.63	1797 1745 1686 1636 11587 11557 1057 1057 741 581 482 2071 2015 2010 2011 2015 2011 2015 2011 2015 2011 2015 2011 2015 2011 2015 2017 2015 2017 2015 2017 2015 2017 2015 2017 2015 2017 2015 2017 2017 2017 2017 2017 2017 2017 2017	-0002 -0001 -0000	1.283 1.073 1.015 1.005 1.005 1.256 2.043 3.127 4.8863 8.985 14.396 23.208 43.894 71.280 115.651 2.005 1.277 1.070 1.006 1.206 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.2111 3.208 2.209	.0001 .0000	96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 406.8 424.7 430.2 = 29.5 50.8 97.5 131.4 151.2 172.6 185.1 252.5 341.7 366.0 390.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4616 1.4503 1.4429 1.3875 1.3225 1.3213 1.2847 1.2559 1.2190 1.2190 1.2190 1.2190 1.1803 1.1481 1.4438 1.4411 1.3931 1.3786 1.3657 1.2999 1.2990 1.2190 1.2190 1.3931 1.3786 1.3657 1.2999 1.2937 1.2932 1.2937 1.2932 1.2937 1.2932 1.1931	0.0002 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000	000 000
1.05 1.20 1.40 1.40 1.60 1.83 2.00 4.00 10.21 20.00 40.00 40.00 100.00 200.00 400.00 1.00 1.00 1.20 1.40 1.40 1.82 2.00 4.00 1.82 2.00 4.00 1.82 2.00 4.00 1.00 1.00 1.00 1.00 1.00 1.00 1	1797 1745 1686 1636 1636 1636 1322 1057 1052 2072 2072 2072 2071 1897 1897 1897 1897 1897 1897 1897 18	.0002 .0001 .0000	1.283 1.073 1.015 1.005 1.256 2.048 2.073 3.127 4.883 8.985 14.396 23.208 43.894 71.280 115.651 30. PERC 2.205 1.277 1.073 1.000 1.266 2.085 2.011 2.005 2.011 2.0		96.6 130.1 152.7 171.8 183.1 249.3 305.6 335.7 359.0 382.4 395.9 406.8 418.7 430.2 = 29.5 50.6 97.5 151.4 152.5 310.4 311.5 341.7 366.0 390.5 400.5	-0101 -0101 -0100	1.4992 1.4867 1.4730 1.4063 1.4429 1.3875 1.3225 1.3225 1.2847 1.2559 1.2100 1.1953 1.1803 1.438 1.438 1.438 1.438 1.438 1.438 1.4393 1.4399 1.2599		

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute

Pressure ratio, P _C /P	Temp- erature, T, °K	exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat, c _p , cal/ig/(°K)	(3 ln m (3 ln P)	(ðin m)
C.		n _t		n _E	(lb)(sec)/lb	n _I	cal/ig/("K)	L`	J
		R = 0.	95, PERC	ENT FUEL	= 26.4	7. U/F	2.778	T	1
1.00	2339	0.0036) ·				1.4271	0.00081	-0.0194
1.95	2317	•0033	2.192	0.0012	50.0	0.0014	1.4164	•00074	0180
1.20	2259	•0026	1.271	•0009	97.6	•0014	1.3889	•00058	0110
1 • 4 0	2195	•0020	1.012	•0005	131.6	•0011 •0010	1.3504	.00043	008
1.50	2087	•0011	1.000	•0000	172.1	•0009	1.3209	•00026	- •006
2.00	2044	•0009	i • 007	0001	185.7	•000₫	1.306B	•00021	- 005
4.00	1772	0001	1.276	-•0006	254.0	•0005	1.2337	•00004	- •001
10.00	1451	0003	2.120	0006	312.9	د 2000 •	1.1659	-00000	000
10.21	1444	0003	2.147	0006	314.0	•0003	1.1645	•00000	000
20.00	1239	0004	3.282	0006	345 • 1	•0002	1.1206	•00000	•000
40.00	1051	-•0004	5.191	-•0005	370.2	*000ī	1.0794	•00000	•000
100.00	835	0004	9.681	0005	395.8	•0001	1.0366	•00000	•000
200.00	702	0004	15.634	0005	410.8	*000 ž	1.0119	•00000	•000
400.00	586	00C+	25.362	0005	422.9	•0001	•9953	•00000	•000
1000 • 00	460	0004	48.312	0005	435.5	•0000	+9789	•00000	• 000
2000+00	382	0004	78.890	-•000>	443.0	-0000	•9694	•00000	• 000
+000•00	317	0004	129.010	0005	449.2	•0000	•9587	•00000	• 000
		R = 0.4	O PERC	ENT FUEL	= 23.9	5, 0/F	= 3.175		
1.00	2553	0.0078					1.4879	0.00219	-0.048
1 • 75	2532	•0074	2.178	0.0022	50.6	0.0029	1.4725	•00205 •00169	- •046 - •038
1.20	2475	• 0063	1.265	•0016	97.2	•0027 •0025	1.4323	•00134	031
1.40 1.60	2410 2353	•0051	1.064	•0004	154.1	•0023	1.3555	-00108	- +025
1.79	2306	•0034	1.000	•0000	170.6	• 0021	1.3293	•00090	- +021
2 • 00	2260	•0028	1.008	0004	185.3	•0020	1.3052	.00074 .00018	018
4.00	1978	•0002	1.286	0017	254.0	•0013	1.1754	•00010	•005
10.00	1638	0008	2.155	0021	313.9	•0007	1.1133	-00002	- •000
10.21	1631	0008	2.182	0021	315.0	•000?	1.1119	•00001	000
20.00	1410	0010	3.358 5.344	0020	346 • 7	•0005 •0004	1.0674	•00000	- 0000
40.00	1206	0010	3.344		3,200	*000+	100230	- 55555	- 555
100.00	971	0011	10+047	~-0018	399.0	د 0000€	9769	•00000	•000
200.00	819	0011	16.311	0018	414.6	•0002	•9479 •9251	•00000	•000
400-10	688	0011	26.513	0018	427•4	•000∠	1,72,71	1 .00000	1000
1000 • 00	543	0011	50.851	0018	440.6	•0001	•9040	•00000	• 000
2000 • 00	376	0012	83.253	0018	448.5	•0001	-8930 -8832	•00000	• 000
4000 • 0 <u>0</u>	378		136.502				1 1111	1 .00000	
	T	R = 0.	45, PERC	ENT FUEL	= 21.8	7. 0/F	= 3.571	1	1
1.00	2733	0.0131	1.165	0.0030	50.1	0.0048	1.5881	0.00457	-0+096
1.05	2713 2659	.0126	2.165	•0022	96.4	•0045	1.>361	•00372	080
1.40	2596	.0096	1.061	•0013	130.2	•0044	1.4792	.00309	- •058
1.60	2542	•0083	1.009	• 0006	153.0	+0040	1.4330	-00261	058
1.77	2499	•0073	1.000	•0000	168.4	•0036 •0036	1.3991	.00227	044
2.00 4.00	2451	•0063	1.009	-•0006 -•0033	253.0	•0025	1.1951	.00061	- 015
4.00	2.1.			i					
10.00	1819	0013	2.193	0046	312.5	•0015	1.0768	+00008	- •002
10.21	1812	0013	2.221 j 3.436	0046	314.7	•0015 •001:	1.0258	.00001	- •000
20 • 00 40 • 00	1359	0018 0040	2.202	0045	373.4	•000g	•9035	•00000	•000
						1	0.25	• nnoon	200
100.00	1105	0022	17.026	0043	417.0	•0005	•9330 •9001	•00000	•000
400.00	939 794	0022	27.879	0043	430.2	•0004	.8730	•00000	
		!				1			1
1000:00	631	0023	53.635	0042	452.6	• 000 d	.8467 .8316	•00000	• 000
2000 • 00 4000 • 00	528 440	0024	144.834	0042	459.5	: 00004	.8211	• 20000	
	1 12			- A	= 20.1	2. U/F	= 3.968		•
		R = 0+	PER!	ENT FOEL	- 200	Ţ <u>, ,,,</u>	1.7727	0.00757	-0.16
1 • 00 1 • 0>	2881 2862	0.0185	. 2.153	0.0032	49.6	0.0066		00764	156
1.20	2811	0165	1.254	.0024	95.3	•0064	1.6893	.00676	- +140
1.40	2752	.0148	1.059	•0014	128.6	•0061	1.6211	.00583	
1.60	2701	•0133 •0123	1.000	•0000	151.5	•0050 •0056	1.5642	•00>09 •604>9	
1 • 76 2 • 00		•0104	1.000	0000	182.4	•00>4	1.4743	• 00349	Odc
4.30	2346	•0042	1.311		251.2	.0041	1.2448	•00159	- •036
	1,		1	1	312.2	•0027	1.0652	•00030	- •00
10.00 10.21	1994	0013	2 • 2 15 2 • 2 6 4		312.2	: •0027	1.0625		008
20.00	1743	0028			346 • 1	•0020	• 9956	•00006	- •00
40.00	1512	0035			373.2	.• OC 15	•9502	•00001	- •000
100 00	1,,,,,		10.029	-•00/8	401.3	•00li	•6994	. •00000	• 000
100.00	1242	0035	10.029			•0000	.8642	•00000	•000
400.00	904	0038	29.218		491.09	•000/	•0340	• 00000	
				:00//	444.4	.000=	•5019	• 6 6 6 0 0 0	•00
		0039	1 50.61/8		440.0	• 0000	-0013	- 00000	
1000 • 00	724 60b		93.451			•0004	•7043	•00000	•00

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute

Pressure ratio,	Temp- erature, T,	Temp- erature exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse, I,	Specific- impolse exponent,	Specific heat,	(3 In 978)	(ðin 97) ðin T
P _c /P	°K	rτ	•	°e	(lb)(sec)/lb	, t	C _p . col/(g)(°K)	(* /7	
		R = Q+	60. PERC	ENT FUEL	= 17.3	5	= 4.762		
							2 2006	0.01775	=0.366
1.00 1.05	3097 3081	0.0278 .0273	2.136	0.0028	48+2	0.0097	2.2005	•01724	-0.345
1.20	3036	•0260	1.247	•0021	92.7	•0095	2.1055	-01587	314
1.40	2985	.0245	1.055	•0012	125.3	+0094	2.0248	.01435	288
1.60	2940	•0232	1.007	•0005	147.5	•0090	1.9551	01310	- +260
1.74	2911	•0223	1.000	•0000	159.9	+0088	1.9107	01232	- •253
2 • 00 4 • 00	2865 2630	•020B •0131	1.013	-•0008 -•0053	177.8 245.9	+0€73	1.5032	•01112	231
	2228		2.321	-	307+2	•0656	1.1596	.00198	049
10:00 10:31	2308	•002B	2.352	0113	308.4	•0(55	1.1536	00192	048
20.00	2058	0028	3.708	0146	342.0	•0044	1.0010	•00062	- +017
40.00	1815	0056	6.038	0159	370+1	+0034	.9136	•00014	- •004
100.00	1518	006B	11.693	0161	399.6	•0(24	-8515	•00001	000
200.00	1317	-•0072	19.413	0160	417.4	•0(19	•B157	•00000	•000
400.00	1135	0075	32.319	0159	432+1	•0(16	•7825	•00000	•000
1000-00	924	0079	63.444	0159	448+2	+0112	•7435	•00000	-000
2000 • 00	786	0082	105.595	0160	457.9	•0:10	•7189	•00000	•000
+000 • 00	665	0084	175.548	0160	466+0	•0:08	•6994	•00000	•000
		R = 0.	70, PERC	ENT FUEL	= 15.2	5. L/F	= 5.556		
1.00	3231	0.0345					2.7036	0.03093	-0.586
1.95	3216	•0342	2.126	0.0022	46 • 7	0.0.18	2.6809	.03031	577
1.20	3176	•0332	1.242	.0016	89.8	•0:17	2+6171	.02863	551
1.40	3130	•0320	1.052	•0010	121.5	•0:15	2 • 5409	.02672 .02509	- +522
1.60	3091	•0309	1.006	•0004 •0000	143.1	•0:13 •0:12	2.4728	.02414	480
1.73 2.00	3068	•0303 •0291	1.000	0007	172.6	•0 09	2.3550	.02242	452
4.00	2823	.0227	1.348	0044	239.3	•0i 99	1.9694	•01481	318
10.00	2550	•0123	2.391	0105	300.2	+0(84	1.4750	•00697	164
10.21	2544	•0121	2.425	010/	301.4	•0L83	1.4650	•00663	161
20.00	2331	•0036	3.886	0160	335 • 4	•0:71	1.1743 .9713	•00316	030
40.00	2102	0040	6.425	0207	364+2	•0:59	•9113	•00111	- •030
100.00	1797	0095	12.637	0237	395.0	+01 44	-8358	•00017	- •005
200.00	1579	0110	21.191	0241	413.9	+0:35	•7871	•00003	- 001
400+00	1379	0117	35.638	0241	429.8	• Oi 29	•7520	•00000	- •000
1000.00	1142	0124	70.952	0242	447.0	•0-22	•7111	•00000	•000
2000+00	983	0129	119.341	-0243	457.6	•0:18	•6825	•00000	• 000
4000-00	841	0134	200+371	0245	466.6	•0: 15	•6576	•00000	•000
		R = 0=	80. PERC	ENT FUEL	= 13.6	0 + 1 /F	= 6.349	1	
1.00	3304	0.0387					3.1245	0.04443	-0.828
1.75	3290	.0384	2.121	0.0017	45+2 87+0	0.0.31 0.29	3.1098 3.0677	•04222	799
1.20	3253	•0376 •0367	1.240	•0012 •0007	117.7	•0 26	3.0158	04035	774
1.60	3174	•0359	1.005	•000•	138.6	•0 26	2.9681	72860.	751
1.72	3154	.0355	1.000	•0000	148.9	•0 25	2.9401	.03781	73E
2.00	3115	.0345	1.016	0005	167.3	•0 24	2.6824	.03601	712
4.00	2935	•0299	1.357	0032	232+2	•0 16	2.5693	•02763	580
10.00	2704	•0224	2.437	0077	292.0	•0 05	2.0604	.01710	389
10.21	2699	.0222	2.472	0078	293.2	•0 04	2.0482	.01688	384
20.00	2526	•0150	4.017	0123	327.1	•0·95 •0·84	1.6425	•01020	247
40.00	2338	•00>6	6.763	-•0183	356.3	•0.84	1.2625	•00500	130
100.00	2064	0069	13.610	0265	1.696	•0 68	•9242	•00131	- •037
200+00	1634	0128	23.116	0302	408.0	•0 56 •0 46	• 7993 • 7393	•00034 •00006	010
400 • 10	1034		1	10325	,,,,,,	•0 .0		-00000	1
1000.00	1375	0169	79.186	0318	443.4	•0 36	•6930 •6639	•00000	- •000
2000•00 •000•00	1199	0177	134.569 228.324	0322	455.0	•0 30 •0 25	.6361	•00000	•000
-000+00	1.7071							1	1
	I	R = 0.	AN' NEKC	ENT FUEL	. 12•2 	P* '/'	* /•143		
		0.0406	2,118	0.0015	43.8	0.0 36	3.2851	0.05319 .05266	-0.982 978
1.00	3336	()404			84.3	•0 35	3.2547	•05127	- •962
1.00	3322	•0404 •0397	1.239	•0011	Lance a	0 34	3.2263	•04965	943
	3322 3286 3246	•0397 •0389	1.051	•0006	114+0		3.1997	•04824	- •927
1.09 1.20 1.40 1.60	3322 3286 3246 3211	.0397 .0389 .0383	1.005	•0006 •0004	134.5	: •0 32			1 - 10 - 1
1.09 1.20 1.40 1.60 1.72	3322 3286 3246 3211 3192	.0397 .0389 .0383 .0379	1.001	•0006 •0004 •0000	154.5	•0 3Z	3+1543	•04747	- •917
1.09 1.20 1.40 1.60	3322 3286 3246 3211 3192 3154	.0397 .0389 .0383	1.005	•0006 •0004 •0000	134.5	: •0 32		•04747 •04289	596
1.05 1.20 1.40 1.60 1.72 2.00 4.00	3322 3286 3246 3211 3192 3154 2984	.0397 .0389 .0383 .0379 .0374 .0375	1.000	•0006 •0002 •0000 -•0004 -•0025	154.3 164.2 162.1 220.2	•0 34 •0 34 •0 30 •0 44	3+1713 2+1713 3+1843	.04747 .04289 .03662	917 894 799
1.05 1.20 1.40 1.60 1.72 2.00 4.00	3322 3286 3246 3211 3192 3154 2984	.0397 .0389 .0383 .0379 .0372 .0395	1.001 1.000 1.000 1.016 1.360	•0006 •0002 •0000 -•0004 -•0025	154.3 164.2 162.1 225.2	•0 34 •0 34 •0 4 •0 4	3.1843 3.1713 2.9668	.04747 .04589 .03862	917 896 799
1.05 1.20 1.40 1.60 1.72 2.00 4.00	3322 3286 3246 3211 3192 3154 2984 2775 2770	.0397 .0389 .0383 .0379 .0372 .0335	1.051 1.005 1.000 1.016 1.360 2.457	-0006 -0002 -0000 -0004 0025 0055 0057	134.3 164.2 162.1 222.2 282.2 284.6	.0 34 .0 34 .0 30 .0 44 .0 15	3.1913 2.9668 2.6406 2.6322	•04747 •04569 •03662 •02912 •0291	915 894 799 645 645
1.05 1.20 1.40 1.60 1.72 2.00 4.00	3322 3286 3246 3211 3192 3154 2984	.0397 .0389 .0383 .0379 .0372 .0395	1.001 1.000 1.000 1.016 1.360	•0006 •0002 •0000 -•0004 -•0025	154.3 164.2 162.1 225.2	•0 34 •0 34 •0 4 •0 4	3.1843 3.1713 2.9668	.04747 .04589 .03862	915 894 795 645 645
1.09 1.20 1.40 1.60 1.72 2.00 4.00 10.00 10.21 20.00 40.00	3322 3286 3246 3211 3192 3154 2984 2175 2770 2623 2474	.0397 .0389 .0383 .0379 .0372 .0393 .0266 .0266 .0241	1.001 1.000 1.000 1.016 1.360 2.407 2.493 4.082 6.960	-0006 -0002 -0000 -0004 -0025 -0025 -0057 -0053 -0118	134.3 164.2 162.1 220.2 264.6 317.9 346.9	.0 32 .0 32 .0 30 .0 24 .0 15 .0 15 .0 06	3.1843 3.1913 2.9660 2.6522 2.3275 1.9960	+04747 +04569 +03662 +02912 +02491 +02207 +01523	915 896 799 645 526 381
1.09 1.20 1.40 1.60 1.72 2.00 4.00 10.21 20.00 40.00	3322 3286 3246 3211 3192 3154 2984 2775 2770 2623 2474 2267	.0397 .0389 .0383 .0379 .0376 .0325 .0266 .0244 .0241	1.001 1.000 1.000 1.016 1.360 2.407 2.403 4.082 6.960	-0006 -0002 -00004 -00025 -00025 -00057 -00053 -0118	134.3 144.2 162.1 220.2 264.0 317.9 346.9	0 32 0 32 0 30 0 44 0 15 0 06 0 01	5.1843 5.1713 2.9668 2.6522 2.5275 1.9760	+04747 +04589 +03862 +02912 +02891 +02207 +01523 +00709	915 896 799 645 645 920 381
1.09 1.20 1.40 1.60 1.72 2.00 4.00 10.00 10.21 20.00 40.00	3322 3286 3246 3211 3154 2984 2775 2770 2623 2474 2267 2092	.0397 .0389 .0383 .0379 .0372 .0393 .0266 .0266 .0241	1.001 1.000 1.000 1.016 1.360 2.407 2.493 4.082 6.960	-0006 -0002 -0000 -0004 -0025 -0025 -0057 -0053 -0118	134.3 144.2 162.1 220.2 264.0 317.9 346.9	.0 32 .0 32 .0 30 .0 24 .0 15 .0 15 .0 06	3.1843 3.1913 2.9660 2.6522 2.3275 1.9960	+04747 +04569 +03662 +02912 +02491 +02207 +01523	915 698 799 645 520 381 194 081
1.09 1.20 1.40 1.60 1.72 2.00 4.00 10.21 20.00 40.00 100.00 200.00 400.70	3322 3286 3246 3211 3192 3154 2984 2770 2623 2474 2267 2092 1896	0397 0383 0383 0379 0372 0372 0372 0266 0264 0241 0185 0076 -0040	1-001 1-000 1-010 1-010 1-360 2-497 2-493 4-082 6-960 14-360 24-776 40-709	-0044 -0140 -0140 -0140 -0140 -0140 -0004 -0004 -0004 -0004 -0004	134.3 144.2 162.1 220.2 284.0 317.9 346.9 375.0 (395.6 417.5	0 32 0 32 0 30 0 24 0 15 0 05 0 01 0 07 0 09 0 08	3.1843 3.1713 2.9660 2.6322 2.3275 1.9560 1.3985 1.0225 .6018	.04747 .04559 .03662 .02912 .02497 .01523 .00709 .00275 .00073	915 695 795 645 520 381 194 081
1.09 1.20 1.40 1.60 1.72 2.00 4.00 10.00 10.21 20.00 40.00	3322 3286 3246 3211 3154 2984 2775 2770 2623 2474 2267 2092	.0397 .0389 .0383 .0379 .0374 .0325 .0466 .0404 .0441 .0185	1-001 1-000 1-010 1-016 1-050 2-407 2-403 4-082 6-960 14-360 24-776	-0006 -0000 -0000 -0005 -0005 -0005 -0005 -0005 -0005 -0005	134.3 144.2 162.1 220.2 284.0 317.9 346.9 375.0 395.6	0 32 0 32 0 32 0 24 0 15 0 06 0 01 0 90	3-1843 3-1713 2-9668 2-6322 2-3275 1-9560 1-3985 1-0225	.04747 .04559 .03662 .02912 .02891 .02207 .01523 .00709 .00275	917 696 795 645 520 381 194 081 023

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Continued. Combustion-chamber pressure, 150 pounds per square inch absolute

Pressure ratio, P _C /P	Temp- erature, T,	Temp- erature exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat, c _s , cal/(8)(°K)	(<u>ð In 201</u> ð In P) ₇	(<u>ð ln 977</u>),
6/5	°K	υt		ⁿ e	(lb)(sec)/lb	u.I	cal/(g)(°K)		Ĭ <u></u>
		R = 1.0	O PERCE	ENT FUEL	= 11.1	9, O/F	= 7.937		,
1.00	3341	0.0410					3-1852	0.05537	-1.0233
1.05	3328	•0407	2.118	0.0014	42.5	0.0137	3.1796	•05488	-1.0184
1.20	3292	+0401	1.238	•0010	81.8	•0136 •0134	3.1630	•05356 •05203	-1.0046
1.40	3252	•0394 •0387	1.050	•0006 •0002	110.7	•0133	3.1225	.05071	9736
1.60 1.72	3199	.0384	1.000	•0000	139.8	.0132	3.1111	•04999	9654
2.00	3161	•0377	1.016	0004	157.3	•0131	3.0866	+04851	9483
4.00	2994	•0344	1.361	0024	218.6	•0125	2.9493	-04178	8627
10.00	2789	•0299	2.462	0051	275.3	.0117	2.7109	.03318	7361
10.00 10.21	2785	.0298	2.498	0051	276.4	•0117	2.7049	•03300	7331
20.00	2644	•0264	4.097	0073	308.7	+0111 +0105	2.4914	•02701 •02121	6325
40.00	2505	•0224	7.007	-•0097	337.0	*0105	2.2430	.021	1,72,10
100.00	2325	.0164	14.608	0135	368+5	•0096	1.8808	.01429	3815
200.00	2188	•0108	25.757	0172	389.0	•0090	1.5942	.00978	2777
400.00	2048	•0040	45.624	0218	407.1	•0082	1.3134	+00606	*****
1000.00	1850	0070	97.111	0295	427.8	•007≥	.9862	•00255	- +0857
2000.00	1686	0158	170.978	0360	441.5	•0064	8018	•00103	0380
4000+00	1517	0229	298.702	0412	453.4	•0055	•6840	•00032	- 10127
		R = 1.5	O PERC	ENT FUEL	= 7.7	4. O/F	= 1.905		
1 00	3219	0.0350					1.9992	0.03449	-0.6756
1.00 1.05	3206	•0347	2.120	0+0017	37.6	0.0120	1.9899	+03400	6690
1.20	3169	.0340	1.240	•0012	72.4	•0119	1.9637	.03266 .03114	6292
1.40	3127	0331	1.051	•0007	97.9	•0117 •0116	1.9320	•02983	6103
1.60 1.72	3091 3071	.0323	1.005	•0003	123.9	•0115	1.8866	.02910	5995
2.00	3031	0309	1.016	0005	139.2	-0113	1.8526	.02767	5780
4.00	2853	•0265	1.357	0030	197.2	+0106	1.6765	.02125	4742
	24.24	•0199	2.439	0069	243.0	•0095	1.4088	.01364	3340
10.00 10.31	2626 2621	•0197	2.474	0070	244.0	•0095	1-4026	-01348	- •3309
20.00	2455	•0140	4.027	0105	272.2	•0087	1.1931	•00880	2329
40.00	2281	•0071	6.805	0149	296.6	•0078	.9827	+00498	1440
100.00	2037	0027	13.824	0214	323.4	•0065	.7495	.00176	0586
200.00	1842	0092	23.681	0258	340.3	•0055	+6298	•00060	0229
400.00	1644	0133	40.495	-•0284	354.7	•0046	•5593	•00016	- •0071
	1303	0158	82-105	0297	370.6	+0036	.5103	•00002	0010
1000.00	1393	0158	139.978	0300	380.6	•0030	+4869	•00000	- • 0002
2000 • 00 4000 • 00	1062	0175	238.311	0302	389 • 2	•0025	•4666	-00000	• 0000
		R = 2.	on. PERC	ENT FUEL	= 5.9	2. O/F	= 5.873		
	Τ	1		1			1.3351	0.01897	-0.4038
1.00	3045	0.0278	2 226	0.0020	34.4	0.0100	1.3254	-01858	3974
1.05 1.20	3031 2992	•0275 •0266	2.126	•0015	66.3	•0098	1.2984	•01750	3799
1.40	2947	+0255	1.052	•0009	89.7	•0096	1.2665	•01629	3596
1.60	2909	•0245	1.006	• 0003	105.6	•0094 •0093	1.2381	.01526	3420
1.73	2886	•0239 •0229	1.000	0006	127.4	.0091	1.1894	01361	312
2 • 00 4 • 00	2845	•0227	1.348	0038	176.6	•008∠	1.0314	•00899	224
4400	20				1				1 2 2 2 2 2
10.00	2386	•0092	2.393	0088	221.6	•0069	.8187	•00434 •00425	122
10.21	2382	.0091	3.895	0128	247.5	•0059	.6852	.00206	- +065
20.00 40.00	1974	0028	6.456	0164	268.9	•0049	•5809	•00079	- +028.
		1	1		1,0,	0027	.4985	.00015	- •006
100.00	1694	0074	12.741	0192	305.9	•0037 •0030	•4656	•00003	- •001
400+00	1492	0090	36.042	0200	317.7	•0024	•4438	•00001	
			!				•4209	•00000	•000
1000 • 00	1084	0103	71.914	0200 0201	336.0	•0019 •0015		•00000	+000
2000 • 00 4000 • 00	803	0107	204.087	0202	345+2	و001ء	• 3906	•00000	-000
		U = 3.		ENT FUEL	_ = 4.0	03, O/F	= 3.810		
	16.35	K = 3.	1.51	T	1	T	0.7383	0.00555	-0.139
1.00	2695	-0149	2.145	0.0025	30.3	0.0059	• 7306	•00>33	135
1.20	2634	.0138	1.251	•0018	58.4	+0057	•7094	•00477	
1.40	2582	.0125	1.057	•0511	78.9	•0054 •0052	•6854 •6650	.00416 .00368	
1.60 1.75	2537 2507	•0114 •0107	1.007	•0004 •0000	92.8	•0051	•6513	.00337	- •092
2.00	2462	•0096	1.012	0006	111.9	•0049	•6319	•00295	- •083
4.00	2226	•0044	1.320	-•0038	154.3	•0038	-5411	•00131	- •041
	1,000		2.2/1	0067	192.3	•0027	. 4589	•00032	- •012
10.00	1914	0004	2.271	0067	193.0	•0026	• 4575	•00031	- •011
20.00	1687	0022	3.601	00/6	213.5	•0020	•4232	•00008	- •003
40.00	1475	0030	2.031	0078	230•6	•0015	•4015	•00002	- •000
!	1334		11.232	007/	248.4	•0011	.3616	•00000	
200.00		0033	18.568	0076	259.1	•0009	•3682	•00000	• 000
400.00		0036	30.867	0075		•0007	• 3559	•00000	•000
	1		40.000	0075	217.6	-0005	.3401	•00000	• 000
1000.00		0037	100.439	0075			• 3292	• 00000	000
2000.00							• 3196	•00000	•000

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(b) Concluded. Combustion-chamber pressure, 150 pounds per square inch absolute

Pressure ratio, P _C /P	Temp- erature, T, °K	Temp- erature exponent, n _T	Area ratio, E	Area- ratio exponent, ne	Specific impulse, I, (b)(sec)/b	Specific- impulse exponent,	Specific heat, cal/(g)(°K)	(<u>ð ln</u> 500) ₇	(ð ln m ð ln t)
	Τ	R = 4.	OO. PERC	ENT FUEL	= 3.0	5. Q/F	= 1.746		
1.00 1.05 1.20 1.40 1.60 1.78 2.00 4.00	2363 2344 2295 2238 2188 2149 2107 1859	0.0064 .0061 .0053 .0044 .0037 .0032 .0027	2.169 1.261 1.062 1.010 1.000 1.009 1.295	0.0018 .0013 .0007 .0003 .0000 0003	27.5 52.8 71.3 83.8 92.4 100.9	0.0026 .0024 .0022 .0021 .0020 .0018	0.5005 .4958 .4833 .4699 .4590 .4509 .4426	0.00142 .00134 .00112 .00091 .00075 .00064 .00053	-0.042 040 034 029 024 021 018
10.00 10.21 20.00 40.00	1555 1549 1350 1166	0007 0007 0009 0010	2.187 2.215 3.431 5.506	0021 0021 0021	171.5 172.1 189.7 204.2	+0008 +0008 +0006 +0004	•3757 •3752 •3616 •3500	•00002 •00002 •00000	- •001 - •001 - •000
100+00 200+00 400+00	953 814 691	0010 0011 0011	10.485 17.201 28.301	0020 0020 0019	219•2 228•1 235•5	•0003 •0002 •0002	•3353 •3244 •3140	•00000 •00000	•0000 •0000
1000 • 00 2000 • 10 • 000 • 30	552 463 387	-•0011 -•0012 -•0012	54.731 90.095 148.169	0019 0020 0020	243.2 247.9 251.7	•0001 •0001 •0001	•3012 •2928 •2864	•00000 •00000	•0000 •0000
		R = 5.0	O. PERC	ENT FUEL	= 2.45	0/F =	9 • 683		
1.00 1.05 1.20 1.40 1.60 1.80 2.00	2066 2048 1998 1941 1892 1850 1812 1578	0.0021 .0020 .0016 .0012 .0010 .0007 .0006 .0000	2.188 1.269 1.066 1.011 1.000 1.007	0.0008 .0005 .0003 .0001 .0000 0001	25 • 2 48 • 4 65 • 3 76 • 7 85 • 2 92 • 2 126 • 2	0.0009 .0008 .0007 .0006 .0006 .0005	0.4020 .3996 .3934 .3869 .3818 .3777 .3742 .3570	0.00033 .00030 .00024 .00018 .00014 .00011 .00009	-0.0118 0109 0089 0070 0056 0046 0038 0010
10.00 10.21 20.00 40.00	1298 1122	0002 0002 0002 0003	2.144 2.171 3.343 5.332	0005 0005 0004 0004	155.7 156.3 171.9 184.7	•0002 •0002 •0001 •0001	.3411 .3408 .3309 .3209	•00000 •00000 •00000	- •0001 - •0001 •0000
100.00 200.00 400.00	658	-•0003 -•0003 -•0003	10.068 16.403 26.799	-•0004 -•0004 -•0004	197.9 205.6 212.0	•0001 •0001	-3076 -2979 -2887	•00000 •00000	•0000 •0000
000.00	365	-•0003 -•0003	51.350 83.996 137.472		218•7 222•6 225•9	•0000 •0000	2782 2728 2693	•00000 •00000	•0000 •0000

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Combustion-chamber pressure, 300 pounds per square inch absolute

Pressure ratio,	Temp- erature T,	exponent,	Area ratio,	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat,	(ðin TR)	(ð in 1777) (ð in 17)
P _c /P	"K	n ₁	·	°E	(lb)(sec)/lb	nı	col/igi(°K)	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	(- /p
			15 0500	ENT FUEL	= 45.6	5- 0/6	= 1.190	•	
	Ţ	R = 0.	13 PERC	I	- 47.0	3, 0/1			
1.00	1183	0.0000	2.360	0.000	47.4	0.0000	1.7752	+00000	0 • 0 0 0 0 • 0 0 0 0
1.05 1.20	1168	•0000	2 • 250 1 • 297	•0000	90.8	•0000	1.7597	•00000	•0000
1 • 40	1085	•0000	1.081	•0000	122.2	•0000	1.7472	•00000	• 0000
1.60	1049	•0000	1.018	•0000	143.2	•0000	1.7369	•00000	. •0000
1 • 8 7 2 • 00	1008	•0000	1.000	•0000	163.4	•0000	1.7257	•00000	• 0000
4.00	824	.0000	1.233	•0000	232+3	•0000	1.6825	•00000	•0000
10.00	643	•0000	1.974	•0000	283.1	•0000	1.6505	•00000	•0000
20.00	532	•0000	2.982	•0000	309.9	•0000	1.6344	•00000	•0000
20•41 40•00	529 439	•0000	3.020 4.620	•0000	330+4	•0000	1.6267	•00000	•0000
100.00	340	•0000	8 • 4 3 2	•0000	350+8	•0000	1+6099	•00000	• 0000
200.00	280	•0000	13.431	•0000	362.6	•0000	1.5970	•00000	•0000
40C • 00	230	•0000	21.488	•0000	372.0	•0000	1.5571	•00000	•0000
1000.00	175	• 2000	39.928	•0000	381.6	• 9000	1.4840	•00000	•0000
2000 • 00	142	-0000	63.512	•0000	387 • 2	•0000	1 • 4387	•00000	•0000
4000 • 00	114	•0000	100.938	•0000	391.6	• 0000	1+4046	•00000	•0000
		R = 0.	20. PERC	ENT FUEL	= 38.6	5. 0/F	1.587		·
1.00	1514	0.0000					1.6188	0.00000	0.0000
1.05 1.20	1497	•0000	2 • 233 1 • 289	•0000	49•3 94•6	0.0000 -0000	1.6144	•00000	-0000
1.40	1398	•0000	1.077	•0000	121.4	•0000	1.5889	•00000	•0000
1.63	1354	•0000	1.016	• 0000	149.4	•0000	1.5773	•00000	•0000
1.85 2.00	1307	•0000	1.000	•0000	169.2	•0000	1.55652	*00000 *00000	•0000
4.00	1079	•0000	1.244	•0000	242.2	•0000	1.5046	•00000	•0000
10.00	852	•0000	2.009	•0000	297.2	•0000	1.4516	•00000	•0000
20.70	709	•0000	3+049	•0000	325.9	•0000	1 • 4232	•00000	• 0000
20 • + i 40 • 00	705	•0000	3.088 4.739	•0000	326 • 7	•0000	1.4225	•00000 •00000	•0000
40.00		•0000	•	1 -0500	•				
100.00	458 379	•0000	13.870	•0000	370 • 0	•0000	1.3913	*00000 *00000	•0000
200•00 400•00	312	•0000	22.296	•0000	393.0	•0000	1.3677	+00000	• 0000
00.0001	242 198	•0000	67.687	•0000	403.5	•0000	1.3402	•00000 •00000	• 0000
+000 • 00	161	•0000	108.755	•3000	414+6	• 0000	1.2571	•00000	•0000
		R = 0.	25. PERC	ENT FUEL	= 33.5	1, U/F	1.984		
1.00	1817	0.0001	[T		,	1.5015	0+00002	-0.0006
1.00	1797	•0001	2.218	0.0001	50.3	0.0001	1 - 4971	•00002	- •0005
1.20	1745	•0001	1.283	•0000	96.6 130.1	•0000	1.4852	•00001	- •0004
1.40	1636	•0000	1.015	•0000	152.7	•0000	1.4609	•00000	- •0002
1.83	1587	•0000	1.000	•0000	171.8	•0000	1-4498	•00000	- •0001
2.00 4.00	1322	•0000 •0000	1.256	•0000	183•1 249•3	•0000	1.4425	•00000 •00000	0001
	i								
10.00 20.00	1057	•0000	2 • 0 4 8 3 • 1 2 7	•0000	305 • 6	•0000 •0000	1.3226	•00000	•0000
20.41	682	•0000	3.168	•0000	336.5	•0000	1.2838	•00000	• 0000
40.00	741	•0000	4 - 883	•0000	359•0	• 0000	1.2560	•00000	• 0000
100.00	581	•0000	8.985	•0000	382.4	•0000	1.2321	•00000	•0000
200.00	482	•0000	14.396	•0000	395.9	• 0000	1.2192	•00000	•0000
400.00	399	•0003	23+208	•0000	406+8	•0000	1.2099	•00000	-0000
1000.00	310	•0000	43.894	•0000	416.1		1.1949	•00000	•0000
2000.00	256	•0000	71.280	•0000 •0000	424 • 7	•0000	1.1801	•00000	•0000 •0000
•900•00	. 210		•					1	
	ſ	. s = 0∙	30. PERC	ENT FUEL	= 29∙5	7. O/F	= 2•3 8 l	т	-
1.00	2093	0.0008				0.0004	1.4230	0.00014	-0.0038
	2072	•0007 •0005	2.206 1.277	0.0003 -0002	97.5	·0003	1.4174	.00013 .00010	- •0026
1•15 1•70	1952	•0004	1.970	•0001	131.4	+0004	1.3869	•00007	- +0019
1.40 1.40		•0002	1.013	•0000 •0000	154.2	•0002 •0004	1.3740	•00005	- +0014
1.40 1.60	1897	•0002	000 1.006	.0000	185.1	•0004	1.3539	•00003	- +0008
1.40 1.40	1897 1846 1809	•0001		0001	252 • 6	+0001	1.2994	•00000	- •0001
1.40 1.40 1.60 1.62	1846	•0000	1.266				1.2336		-0000
1.40 1.60 1.82 2.00 4.00	1846 1809 1553	•0000		0001	310+4	. +0000		• 00000	
1.40 1.60 1.60 1.62 2.00	1846 1809 1553 1257 1364	-•0001 -•0001	2•085 3•206	-+0001 -+0001	341.7	•0000	1.1891	•00000	• 0000
1.40 1.60 1.60 1.82 2.00 4.00 10.00 20.00 20.41	1846 1809 1553 1257 1064 1059	0001 0001 00001	2+985 3+206 3+248	0001	341.7	•0000	1.1891	•00000	•0000 •0000
1.40 1.60 1.82 2.00 4.00	1846 1809 1553 1257 1364	-•0001 -•0001	2•085 3•206	0001	341.7	•0000	1.1891 1.1878 1.1531	•00000	•0000 •0000
1.40 1.40 1.60 1.82 2.30 4.90 10.90 20.41 40.00	1846 1809 1553 1257 1364 1359 895	0001 0001 0001 0001	2.085 3.206 3.248 5.037	0001	341.7 342.5 366.0	•0000 •0000 •0000	1.1891 1.1878 1.1531	•00000 •00000	•0000 •0000 •0001
1.20 1.40 1.60 1.82 2.00 4.90 10.90 20.41 40.00	1846 1809 1553 1257 1364 1359 895 707 590	0001 0001 0001 0001 0001	2.085 3.206 3.248 5.037 9.325 14.993	0001 0001	341.7 342.5 366.0 390.5 404.8	•0000 •0000 •0000	1.1878 1.1531 1.1173 1.1006	•00000 •00000 •00000 •00000	• 0000 • 0000 • 0000 • 0000
1.20 1.40 1.60 1.60 1.62 2.00 4.90 10.90 20.41 40.00	1846 1809 1553 1257 1364 1359 895	0001 0001 0001 0001	2.085 3.206 3.248 5.037	0001	341.7 342.5 366.0 390.5 404.8 416.3	.0000 .0000 .0000 .0000	1.1891 1.1878 1.1531 1.1173 1.1006 1.0865	•00000 •00000 •00000 •00000 •00000	• 0000 • 0000 • 0000 • 0000 • 0000
1.20 1.40 1.60 1.82 2.00 4.90 10.90 20.41 40.00	1846 1809 1553 1257 1064 1059 892 707 590 493	0001 0001 0001 0001 0001 0001 0001	2.085 3.206 3.248 5.037 9.325 14.993	0001 0001	341.7 342.5 366.0 390.5 404.8 416.3	.0000 .0000 .0000 .0000	1.1891 1.1878 1.1531 1.1173 1.1006 1.0865	•00000 •00000 •00000 •00000	

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute

ratio,	Temp- erature,	Temp- erature	Area ratio,	Area- ratio	Specific impulse,	Specit c- impulse		(ð in 切) ð in P)	(<u>9 lo 20</u> 2)
P _c /P	T, °K	exponent, n _t	ε	exponent,	1, (lb)(sec)/lb	expon∈n1,	col/(g)(°K)	(dlu P/T	(am 1 %
				· •		! . '			
		R = 0.	5, PERC	ENT FUEL	= 26.4	/• 0/F	= 2.778		,
	2344	0.0026			ļ		1.3936	0.00059	-0.014
1.00	2322	•0024	2.194	0.0009	50.9	0.0010	1.3850	. 00054	- •0130
1.20	2263	•0019	1.272	•0006	97.7	•0009	1.3629	+00042	- •0104
1.40	2196	•0014	1.058	•0004	131.7	•00€8	1.3398	•00031	- •007
1.60	2139	-0011	1.012	•0001	172.3	■00€7 ■00€6	1.3219	+00024 +00018	- •004
1.80 2.00	2088	+0008 +0006	1.000	-0000 0001	185.8	■000 6	1.2955	•00015	- •004
4.00	1771	0001	1.275	0004	254.0	•0014	1.2:10	•00003	- •000
10.00	1451	0003	2.119	0004	313.0	•0004	1-1657	•00000	•000
10.00 20.00	1238	00c3	3.281	0004	345-1	•00(1	1.1205	•00000	•000
20.41	1232	0003	3.325	0004	345.9	• 00(l	1.1192	•00000	•000
40.00	1051	-•0003	5.189	0004	376.2	•00(1	1.0794	•00000	•000
100.00	838	-•0003	9.678	0004	395.8	. +00(1	1.0365	•00000	•000
200.00	702	0003	15.630	0003	410.8	•00(1	1.0119	•00000	•000
400.00	586	-•0003	25.355	-•0003	422.9	•0010	•9954	•00000	•000
000 • 00	460	0003	48.298	-•0003	435.5	•0000	.9791	• 00000	•000
000-00	362	0003	78.868	0003	443.0	•0000	•9692	• 00000	•000
000.00	317	0003	128.975	-•0003	449.2	•0000	•9598	•00000	•000
		R = 0.0	O. PERC	ENT FUEL	= 23.9	5. 0/F	= 3.175		
1.00	2565	0.0061		Ţ	Ī		1.4207	0.00163	-0.036
1.05	2543	•0057	2.181	0.0018	20.7	0.00. 3	1.4084	•00152	- •034
1.20	2484	.0048	1.267	•0013	97.4	•00.1	1.3764	•00125	- •02B
1.40	2417	.0038	1.065	•0007	131.4	•00 9	1.3423	•0009B	- •023
1.60	2359	•0031	1.011	•0003	154.4	•00 7 •00 6	1.3153	+00079 +00065	019
1.79 2.00	2310	•0025	1.000	•0000 ••0003	185.6	•00 5	1-2752	•00053	013
4.00	1978	•0001	1.285	0013	254 • 2	• 00: 9	1.1857	•00013	- •003
10.00	1637	0006	2.152	0015	314•0	•00· b	1.1119	•00001	- •000
10.00 20.10	1409	0007	3.354	0014	346.8	• 00- 4	1.0671	•00000	•000
20.41	1403	0007	3.399	0014	347.6	•00 4	1.0658	•00000	•000
40.00	1205	0008	5.338	0014	372.6	•00⊕3	1.0255	•00000	•000
100.00	970	0008	10.036	0013	399 • 1	•00€4	• 9768	•00000	•000
200.00	819	0008	16.294	0013	414.7	•0002	•9478 •9250	•00000	•000
400.00	687	0008	26.545	0013	427.4	•00 1	• 7250	•00000	•000
1000.00	542	0009	50.799	0013	440.7	•00 1	•9038	•00000	•000
2000.00	452	0009	83.167	0013	448 • 6 455 • 1	• 00: 1 • 00: 1	-8929 -8831	-00000	•000
+000 • 00	376	0009	136.362	0013	143361			-00000	-000
	, -	R = 0.	5 PERC	ENT FUEL	= 21.6	7 0 F	= 3.571		1.
1.00	2755	0.0107				1	1.5003	0.00351	-0.073
1.05	2734	•01C2	2.169	0.0026	50.3	0.00 9	1.4843	•00332	- •070
1.20	2677	•0090	1.261	•0019	96 • 7	•00 7	1 - 4419	•00283	- •061
1.40	2611	•0076	1.062	•0011	136.5	•00 4	1.3588	.00233 .00195	051
1.60 1.78	2555 2510	•0065 •0056	1.010	•0005	169.1	•00 0	1.3312	.00168	- 038
2.00	2460	•0048	1.009	0005	184.6	•00 8	1.3023	.00142	
4.00	2173	.0010					1.1697		052
		*00-0	1.295	0026	257.4	•00 0	101071	•00044	
	1818	-	1.295	0026				•00044	- •011
10.00	1818 1576	0010	2.187	0026	313.8 347.2	•00 0 •00 2 •00 19	1.0/17		011
	1576 1569	0010 0014 0014	2.187 3.427 3.474	0026 0035 0034 0034	313.8 347.2 348.1	•00 2 •00 19 •00 19	1.0/17 1.0246 1.0233	.00001 .00009	011 001 000 000
10.00	1576	0010 0014	2.187 3.427	0026 0035 0034	313.8 347.2	•00 d •00 19	1.0/17	•00001	011 001 000 000
10.00 20.70 20.41 40.00	1576 1569 1358	0010 0014 0014 0015	1.295 2.187 3.427 3.474 5.487	0026 0035 0034 0034	313.8 347.2 348.1 373.6	•00 2 •00 19 •00 19 •00 16	1.0717 1.0246 1.0233 .9831	•00006 •00001 •00001 •00000	011 001 000 000 .000
10.00 20.30 20.41 40.00 100.00 200.00	1576 1569 1358 1105 938	0010 0014 0014 0015 0016 0017	1.295 2.187 3.427 3.474 5.487 10.401 16.983	0026 0035 0034 0033 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1	•00 2 •00 19 •00 19 •00 16	1.0/17 1.0246 1.0233 .9831 .9327 .8999	•00006 •00001 •00001 •00000	011 001 000 000 000
10.00 20.30 20.41 40.00	1576 1569 1358	0010 0014 0014 0015	1.295 2.187 3.427 3.474 5.487	0026 0035 0034 0034 0033	313.8 347.2 348.1 373.6	•00 2 •00 19 •00 19 •00 16	1.0717 1.0246 1.0233 .9831	•00006 •00001 •00001 •00000	032 011 001 000 000 .000
10.00 20.30 20.41 40.00 100.00 200.00 400.00	1576 1569 1358 1105 938 793	0010 0014 0014 0015 0016 0017	1.295 2.187 3.427 3.474 5.487 10.401 16.983	0026 0035 0034 0033 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1	•00 2 •00 19 •00 19 •00 16	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728	•00006 •00001 •00001 •00000	011 000 000 000 .000 .000
10.00 20.70 20.41 40.00 100.00 200.00 400.00	1576 1569 1358 1105 938 793 630 527	0010 0014 0015 0015 0017 0017 0018 0018	1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879	0026 0034 0034 0033 0032 0032 0032 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6	•00 2 •00 19 •00 19 •00 16 •00 15 •00 14 •00 13	1.0/17 1.0/246 1.0/233 .9831 .9327 .8999 .8728	.00006 .00001 .00001 .00000 .00000 .00000	011 001 000 000 .000 .000 .000 .000
10.00 20.70 20.41 40.00 100.00 200.00 400.00	1576 1569 1358 1105 938 793 630	0010 0014 0015 0015 0017 0017 0018 0018	1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808	0026 0034 0034 0033 0032 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1 430.3	•00 2 •00 19 •00 19 •00 16 •00 14 •00 13	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728	.00006 .00001 .00001 .00000 .00000 .00000	011 001 000 000 .000 .000 .000
10.00 20.30 20.41 40.00 100.00 200.00	1576 1569 1358 1105 938 793 630 527	0010 0014 0015 0015 0017 0017 0018 0018	1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.508 53.499 87.879 144.468	0026 0034 0034 0033 0032 0032 0032 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5	•00 2 •00 19 •00 19 •00 16 •00 15 •00 14 •00 13	1.0/17 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315	.00006 .00001 .00001 .00000 .00000 .00000	011 001 000 000 .000 .000 .000 .000
10.00 20.70 20.41 40.00 100.00 200.00 400.00	1576 1569 1358 1105 938 793 630 527 440	0010 0014 0014 0015 0017 0017 0018 0018 R = 0-	1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.408	0026 0035 0034 0034 0033 0032 0032 0032 0032 0031 ENT FUEL	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5	.00 2 .00 19 .00 19 .00 16 .00 14 .00 13 .00 12 .00 14	1.0/17 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8211 = 3.968	.00006 .00001 .00001 .00000 .00000 .00000 .00000 .00000	011 001 000 000 000 000 000 000 000 000 000 000
10.00 20.70 20.41 40.00 100.00 200.00 400.00 1000.00 2000.00 1000.00	1576 1569 1358 1105 938 793 630 527 440	0010 0014 0014 0015 0017 0018 0018 0018 R = 0-00158 0158	1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.508 53.499 87.889 144.408 50. PERC	0026 0035 0034 0033 0032 0032 0032 0032 0032 0032 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 = 20.1	.00 2 .00 19 .00 19 .00 16 .00 15 .00 14 .00 12 .00 14 2. 0 F	1.0/17 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 = 3.968 1.6231 1.6042	.00006 .00001 .00001 .00000 .00000 .00000 .00000 .00000	011 001 000 000 000 000 000 000 000 000 000 000 000 000
10.00 20.00 20.01 40.00 100.00 200.00 400.00 1000.00 2000.00 4000.00	1576 1569 1358 1105 938 793 630 527 440	0010 0014 0014 0015 0016 0017 0018 0018 0018 0018 0018 0018 0019	1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.468 50. PERC	0026 0034 0034 0033 0032 0032 0032 0032 0032 0032 0032 0032 0032 0032 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.8 49.8 95.7	•00 2 •00 19 •00 19 •00 16 •00 14 •00 13 •00 14 •00 14 •00 14	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 = 3.968 1.6042 1.6042 1.5535	.00006 .00001 .00001 .00000 .00000 .00000 .00000 .00000 .00000	011 001 000 000 000 000 000 000 000 000 000 000 000
10.00 20.00 20.01 40.00 100.00 200.00 400.00 1000.00 200.00 400.00 1.00 1.00 1.00 1.00	1576 1569 1358 1105 938 793 630 527 440 2915 2895 2841 2778		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.408 50, PERC 2.158 1.256 1.256 1.256	0026 0035 0034 0033 0032 0032 0032 0031 ENT FUEL 0-0029 0022 0012	313.8 347.2 348.1 373.6 400.9 417.1 430.5 444.3 452.6 459.5 20.1 49.8 45.7 129.5	•00 2 •00 19 •00 19 •00 15 •00 14 •00 12 •00 11 2, 00 F	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 = 3.968 1.6231 1.6042 1.5535 1.4970	.00006 .00001 .00001 .00000 .00000 .00000 .00000 .00000	011 001 000 000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000
10.00 20.00 20.01 40.00 100.00 200.00 400.00 1000.00 1000.00 1000.00 1.00 1	1576 1569 1358 1105 938 793 630 527 440		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.468 50. PERC	0026 0034 0034 0033 0032 0032 0032 0032 0032 0032 0032 0032 0032 0032 0032 0032	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.8 49.8 95.7	00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 .8211 1.6042 1.5535 1.4970 1.4502 1.4168	.0006 .0001 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000	011 001 000
10.00 20.00 20.01 40.00 200.00 200.00 400.00 1000.00 200.00 400.00	1576 1569 1358 1105 938 793 630 527 440 2915 2895 2894 12778 2724 2633		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.408 50. PERC 1.256 1.000 1.010	0026 0035 0034 0033 0032 0032 0032 0032 0032 0031 ENT FUEL 0-0029 0022 0013 0000 0000 0000	313.8 347.2 348.1 373.6 400.9 417.1 430.3 422.6 427.2 427.1 49.8 95.7 129.3 152.0 166.6	.00 2 .00 19 .00 19 .00 16 .00 14 .00 13 .00 12 .00 12 .00 14 .00 14 .00 14 .00 14 .00 19 .00 14 .00 19 .00 10 10 .00 10 .00 10 .00 10	1.0717 1.0246 1.0233 .9831 .9831 .9327 .8499 .8728 .8465 .8211 2 3.968 1.6231 1.6042 1.5535 1.4970 1.4502 1.4168 1.3768	.00006 .00001 .00001 .000000	011 001 000
10.00 20.00 20.01 40.00 100.00 200.00 400.00 1000.00 2000.00 1000.00 1.00 1.00	1576 1569 1358 1105 938 793 630 527 440 2915 2895 2841 2778 2784 2684		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.406 50. PERC 2.158 1.256 1.000 1.000	0026 0035 0034 0033 0032 0032 0032 0031 ENT FUEL 0-0029 0022 0013 0006 0009	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 20.1 49.8 95.7 129.3 152.0 166.6	00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 .8211 1.6042 1.5535 1.4970 1.4502 1.4168	.00006 .00001 .00000 .00000 .00000 .00000 .00000 .00000 .00000	011 001 000
10.00 20.00 20.1 40.00 20.00 400.00 100.00 200.00 400.00 1000.00 1000.00 1000.00 1.00 1	1576 1569 1358 1105 938 793 630 527 440 2915 2841 2778 278 2724 2684 2633 2352		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.408 50. PERC 1.256 1.000 1.010 1.010 1.507	0026 0035 0034 0033 0032 0032 0032 0032 0032 0031 ENT FUEL 0-0029 0022 0013 0000 0000 0000	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 20.1 49.8 95.7 129.3 152.0 166.6 183.0 201.9	.00 2 .00 19 .00 19 .00 16 .00 14 .00 13 .00 12 .00 12 .00 14 .00 14 .00 14 .00 14 .00 19 .00 14 .00 19 .00 10 10 .00 10 .00 10 .00 10	1.0/17 1.0246 1.0233 .9831 .9831 .9327 .8999 .8728 .8465 .8315 .8211 1.6042 1.5035 1.4970 1.4502 1.45436 1.4535 1.4970 1.4502 1.45436 1.4535 1.4970 1.4502	.00006 .00001 .00001 .000000	011 000
10.00 20.00 20.01 40.00 100.00 200.00 400.00 100.00 2000.00 400.00	1576 1569 1358 1105 938 793 630 527 440 2915 2895 2894 12778 2724 2633		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.408 50. PERC 1.256 1.000 1.010	0026003400340032003200320031003100310031003100310031003100310031003100310031	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 20.1 49.8 45.7 129.3 152.0 166.6 183.0 201.9	00 2 00 19 00 19 00 19 00 16 00 14 00 12 00 12 00 11 2, 0 F	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 .8211 1.6042 1.5535 1.6042 1.4970 1.4502 1.4160 1.4176 1.4176 1.4176 1.4176 1.4176 1.4176	0.0006 0.0001 0.0001 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0	011 000 -
10.00 20.00 20.00 100.00 200.00 100.00 200.00 1	1576 1569 1358 1105 938 793 630 527 440 2915 2894 12778 2778 2724 2633 2352 1992 1740 1732		1.295 2.187 3.427 3.427 5.487 10.401 16.983 27.808 53.499 81.879 144.460 50, PERC 2.158 1.256 1.060 1.000 1.010 1.3107 2.224 2.504 2.504	0026003200320032003200320031003100310031003100310031003100310031	313.8 347.2 348:1 373.6 400.9 417.1 430.3 444.3 452.6 457.5 129.3 152.0 166.6 183.0 201.9	00 6 00 19 00 19 00 19 00 10 00 16 00 16 00 16 00 17 00 17 00 19 00 10 10 10 10 10 10 10 10 10 10 10 10 1	1.0/17 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8211 1.6042 1.5535 1.4970 1.4502 1.4168 1.376d 1.1376d 1.9916	00006 00001 00000 00000 00000 00000 00000 00000 0000	011 001 000
10.00 20.10 20.11 40.00 100.00 200.00 400.00 100.00 200.00 10	1576 1569 1358 1105 938 793 630 527 440 2915 2895 2841 2774 2684 2633 2724 2684 2724 2683 2724 2736 2740		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 144.400 1.256 1.256 1.256 1.256 1.256 1.257	0026003400340032003200320031003100310031003100310031003100310031003100310031	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 20.1 49.8 45.7 129.3 152.0 166.6 183.0 201.9	00 2 00 19 00 19 00 19 00 16 00 14 00 12 00 12 00 11 2, 0 F	1.0717 1.0246 1.0233 .9831 .9327 .8999 .8728 .8465 .8315 .8211 .8211 1.6042 1.5535 1.6042 1.4970 1.4502 1.4160 1.4176 1.4176 1.4176 1.4176 1.4176 1.4176	0.0006 0.0001 0.0001 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0	011 000 -
10.00 20.00 20.00 100.00 200.00 100.00 200.00 1	1576 1569 1358 1105 938 793 630 527 440 2915 2894 12778 2778 2724 2633 2352 1992 1740 1732		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 14.4.460 50. PERC 2.158 1.256 1.000 1.010 1.307 2.224 3.504 3.504 3.504 10.777	002600320032003200320032003200320032003400310040040064006400640064	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 129.3 152.0 166.6 183.0 201.9 312.9 312.9 444.3 452.6 475.7 476.7 47	00 2 00 19 00 19 00 15 00 14 00 12 00 12 00 12 00 12 00 12 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 16 0	1.0/17 1.0/246 1.0/23 .9831 .9831 .8465 .8315 .8211 1.6042 1.5535 1.4970 1.4502 1.4168 1.3768 1.936 1.	.00006 .00001 .00001 .000000	011 000 -
10.00 20.10 20.10 40.00 100.00 200.00 400.00 100.00 200.00 1.00	1576 1569 1358 1105 938 793 630 527 440 2915 2841 2778 2778 2724 2633 2352 1992 1740 1732 1509 12460		1.295 2.187 3.427 3.427 3.474 5.487 10.401 16.983 27.508 55.499 81.819 144.408 50, PERC 2.158 1.256 1.050 1.000 1.010 1.307 2.224 3.504 2.505 3.607 2.777 17.699	0026003400320032003200320031003100310031003100310031003100310031003100310061006100610061	313.8 347.2 347.2 347.2 340.9 417.1 430.3 452.6 459.5 20.1 49.8 95.7 129.3 152.0 166.6 183.0 251.9 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5	00 2 00 19 00 19 00 10 00 14 00 12 00 12 00 12 00 12 00 12 00 14 00 14 00 14 00 14 00 14 00 14 00 17 00 19 00 10 10 10 10 10 10 10 10 10 10 10 10 1	1.0/17 1.0/246 1.0/233 .9831 .9831 .8465 .8315 .8411 = 3.968 1.60/23 1.60/22 1.5535 1.4970 1.4502 1.4168 1.3768 4.1732 1.0008 .9916 .9916 .9916 .9926 .9926 .9936 .9936	0.0006 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.000000	011 001 000 -
10.00 20.00 20.00 100.00 200.00 100.00 200.00 100.00 100.00 100.00 1.00 1.20 1.40 1	1576 1569 1358 1105 938 793 630 527 440 2915 2895 2841 2778 2778 2778 2724 2634 2352 1992 1732 1509		1.295 2.187 3.427 3.474 5.487 10.401 16.983 27.808 53.499 87.879 14.4.460 50. PERC 2.158 1.256 1.000 1.010 1.307 2.224 3.504 3.504 3.504 10.777	002600320032003200320032003200320032003400310040040064006400640064	313.8 347.2 348.1 373.6 400.9 417.1 430.3 444.3 452.6 459.5 129.3 152.0 166.6 183.0 201.9 312.9 312.9 444.3 452.6 475.7 476.7 47	00 2 00 19 00 19 00 15 00 14 00 12 00 12 00 12 00 12 00 12 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 14 00 16 0	1.0/17 1.0/246 1.0/23 .9831 .9831 .8465 .8315 .8211 1.6042 1.5535 1.4970 1.4502 1.4168 1.3768 1.936 1.	.00006 .00001 .00001 .000000	011 001 000 -
10.00 20.10 20.10 40.00 100.00 200.00 400.00 100.00 200.00 1.00	1576 1569 1358 1105 938 793 630 527 440 2915 2841 2778 2778 2724 2633 2352 1992 1740 1732 1509 12460		1.295 2.187 3.427 3.427 3.474 5.487 10.401 16.983 27.508 55.499 81.819 144.408 50, PERC 2.158 1.256 1.050 1.000 1.010 1.307 2.224 3.504 2.505 3.607 2.777 17.699	0026003400320032003200320031003100310031003100310031003100310031003100310061006100610061	313.8 347.2 347.2 347.2 340.9 417.1 430.3 452.6 459.5 20.1 49.8 95.7 129.3 152.0 166.6 183.0 251.9 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5 347.5	00 2 00 19 00 19 00 10 00 14 00 12 00 12 00 12 00 12 00 12 00 14 00 14 00 14 00 14 00 14 00 14 00 17 00 19 00 10 10 10 10 10 10 10 10 10 10 10 10 1	1.0/17 1.0/246 1.0/233 .9831 .9831 .8465 .8315 .8411 = 3.968 1.60/23 1.60/22 1.5535 1.4970 1.4502 1.4168 1.3768 4.1732 1.0008 .9916 .9916 .9916 .9926 .9926 .9936 .9936	0.0006 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.000000	011 000 -

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute

Pressure ratio,	Temp- erature T,	Temp- erature exponent,	Area ratio,	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat,	(din 900),	(ðin m)
P _c /P	°K	n _T	ε	n _e	I, (No)(sec)/No	n ₁	cal/(g)(°K)	(dln P)7	10 in Th
		R = 0.	60. PERC	ENT FUEL	= 17.3	5, 0/F	= 4.762		
1.00	3155	0.0254					1.9667	0.01480	-0.2833
1.05	3137	.0249	2.140	0.0028	48.5	0.0088	1.9446	.01434	2759
1.20	3089	.0235	1.248	•0021	95.3	•0085	1.8842	.01312	2559
1.40	3033	•0220	1.056	•0013	126.1	•0083	1.8145	.01177	2335
1.50	2985	•0206	1.007	•0005	148.4	•0080	1.7545	+01067	2145
1.75 2.00	2953 2904	•0197 •0182	1.000	0008	161.2 178.8	•0079 •0076	1+7154	+00997 +00894	2024
4.00	2652	.0106	1.328	0051	247.0	.0064	1.3741	•00466	1037
10.00	2311	.0015	2.303	0104	308.3	•0047	1.0984	+00142	0356
20.00	2054	0029	3.673	0127	343+0	•0036	•9752	+00043	0118
20.41 40.00	2047 1808	0029 0049	3.726 5.977	0128 0136	343.9 370.9	•0036 •0028	•9726 •9053	+00041 +00009	- •0113
				l .				i	
100.00 200.00	1512	0058 0061	11.573	0136 0135	418.0	•0020 •0016	.8496 .8145	•00000	- •0003
400.00	1130	0063	31.993	0134	432.7	.0013	.7815	•00000	•0000
1000-00	919	0066	62.803	0134	448.6	•0010	.7427	•00000	•0000
2000-00	782	0069	104.524	0135	458.2	•000B	7183	•00000	• 0000
4000-00	661	-+0071	173.763	0135	466.3	•0007	•6988	•00000	•0000
		R = 0.	70. PERC	ENT FUEL	= 15.2	0/F	= 5.556		
1.00	3307	0.0328					2.3992	0.02681	-0.4983
	3291	•0324	2.129	0.0023	47.0	0.0111	2.3785	.02623	4898
1.20	3248	•0314	1.244	•0017	90.6	•0109	2.3204	02465	4663
1.40 1.60	3198 3156	•0301 •0289	1.053	•0010 •0004	122.4	•0107 •0105	2.2512	.02286 .02134	4389
1.73	3130	•0282	1.000	+0000	155.6	+0105	2.1520	•02044	- 400
2.00	3085	•0269	1.014	0007	173.9	•0102	2.0841	.01889	3752
4.00	2865	•0201	1.344	-•0046	240.8	•0091	1.7441	•01201	2554
10.00	2569	•0096	2.374	0108	301.9	•0075	1.3258	•00529	1237
20.00	2335	•0015	3.843	0156	336.9	•0063	1.0849	•00226	0574
20.41 40.00	2328	0013	3.900 6.337	0158 0193	337.9 365.6	•0062 •0051	1.0791	•00219 •00075	0557
					204 1		.8253	•00011	0035
200.00	1785 1568	0086 0097	20.858	0212	396 • 1 414 • 9	•0038 •0030	.7835	•00002	- •0006
400.00	1368	0102	35.080	0214	430+6	•0025	• 7500	•00000	0001
1000-00	1133	0108	69.841	0214	447.6	•0019	•7094	•00000	•0000
2000•00	975	0113	117.461	0215	458.2	•0016	-6811	•00000	•0000
4000.00	834	0117	197.192	0217	467.0	•0013	.6564	•00000	•0000
		R = 0.	BO, PERC	ENT FUEL	= 13.6	0 + 0/F	6.349		
1.00	3393	0.0377	3 132		45.6	0.0126	2.7921 2.7781	0.03990 .03933	-0.7279 7206
1.05 1.20	3338	.0374 .0366	2.123 1.241	0.0018 .0013	87.8	•0124	2.7382	.03775	7001
1.40	3292	•0356	1.052	•0008	118.7	.0122	2.6891	.03593	6756
1.60	3253	.0347	1.005	•0003	139.8	.0121	2.6439	.03435	6538
1.73	3231	•0342	1.000	•0000	150.4	•0120	2-6168	.03345	6410
2.00 4.00	3189 2995	+0332 +0282	1.015 1.354	0005 0034	168.7 234.0	.0118	2.5628 2.2689	.03173 .02369	616g
								i	
10.00 20.00	2744 2550	•0199 •0118	2.423 3.982	-•0083 -•0132	294.1 329.1	.0098 .0088	1.8019	•01386 •00779	3122
20.41	2544	.0116	4.042	0134	330.1	.0087	1.4265	.00763	1844
40.00	2344	•0025	6.676	0191	358.3	•0076	1.1265	•00355	0922
100.00	2053	0080	13.365	0258	389.8	•0060	.8717	+00085	0245
200.00	1830	0123	22.652	-•0282	409.5	•0050	.78 ₀ 5	•00021	0066
400.00	1617	0141	38.453	0289	426.2	.0041		+00004	0013
1000.00	1360	0152	77.533	~•0291	444.4	•0031 •0026	•6903	•00000	- •0001
2000 • 00 • 000 • 00	1185	0159	131.747 223.495	-•0292 -•0294	455.9 465.6	•0022	•6615 •6339	+00000	•0000
		R = 0.	90. PERC	ENT FUEL	= 12.2	3. O/F	7.143		
1.00	3430	0.0401					2.9626	0+04890	-0.8833
1.05	3416	•0393	2.121	0.0015	44.2	0.0132	2.9553	·04840	8780
1.20	3377	•0391	1.240	•0011	85.1	.0131	2.9343	.04704	8631
1.40	3334	•0383	1.051	•0006	115.1	•0129	2.9078	•04546	8452
1.60	3296 3276	•0376 •0372	1.005	•0002	135.5	•0128 •0127	2.8830 2.8682	+04409 +04332	8291 8199
1.79	3235	0364	1.016	-0000	163.6	.0126	2.8374	•04180	8012
1.72 2.00	3054	•0326	1.358	0026	227.1	.0119	2.6636	.03473	7059
1.72 2.00 4.00		.0271	2.448	-•0058	285.8	.0110	2.3536	•02551	- •5605
2 • 00 4 • 00	2829			0088	320.2	.0103	2.0547	.01871	- •4366
2.00	2829 2666	•0222	4.058		321.2	•0103	2.0450	•01851	4328
2.00 4.00 10.00 20.00 20.41	2666 2661	•0222 •0220	4.121	-e0n89		.0005	1.7022		3040
2.00 4.00 10.00 20.00	2666	•0222		0128	349.2	•0095	1.7023	•01221	
2.00 4.00 10.00 20.70 20.41 40.00	2666 2661 2503 2276	.0222 .0220 .0158	4.121 6.901 14.187	0089 0128	349.2	•0095 •0083	1.2030	+00498	1364
2.00 4.00 10.00 20.10 20.41 40.00 100.00 200.00	2666 2661 2503 2276 2084	.0222 .0220 .0158 .0037 0074	4.121 6.901 14.187 24.518	0089 0128 0208 0284	349•2 381•3 401•7	•0095 •0083 •0073	1.2030	+00498 +00171	3040 1364 0508 0136
2.00 4.00 10.00 20.70 20.41 40.00	2666 2661 2503 2276	.0222 .0220 .0158	4.121 6.901 14.187 24.518 42.200	0128 0128 0208 0284 0336	349.2 381.3 401.7 419.4	•0095 •0083 •0073 •0061	1.2030 .9125 .7617	+00498 +00171 +00042	1364 0508 0136
2.00 4.00 10.00 20.00 20.41 40.00 100.00 200.00	2666 2661 2503 2276 2084	.0222 .0220 .0158 .0037 0074	4.121 6.901 14.187 24.518	0089 0128 0208 0284	349•2 381•3 401•7	•0095 •0083 •0073	1.2030	+00498 +00171	1364

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Continued. Combustion-chamber pressure, 300 pounds per square inch absolute

P _C /P	Temp- erature, T, °K	Temp- erature exponent, n _T	Area ratio, E	Area- ratio exponent,	Specific impulse, 1, (lb)(sec)/lb	Specific- impulse exponent, n ₁	Specific heat, c _p , cal/(g)(^a K)	(<u>∂ in 102</u>),	(ðin 17) (ðin 17)
		''1		3 ⁿ	(Ib)(sec)/Ib	"1	cal/(g)(°K)	<u> </u>	1
		R = 1.	00. PERC	ENT FUEL	= 11.1	9. 0/F	= 7.937		
1 00	3437	0.0405					2.8811	0.05123	-0.924
1.00 1.05	3423	•0403	2.120	0.0014	42.9	0.0153	2.8760	05076	919
1.20	3384	.0396	1.239	•0010	82.6	•0132	2.8611	.04948	906
1.40	3341	.0389	1.051	•0006	111.7	.0101	2.8421	.04800	89
1.60	3304	.0382	1.005	•0002	131.5	-0129	2.8243	•04672	877
1.72	3284	.0378	1.000	-0000	141.3	.0129	2.8138	.04601	86
2.00	3244	.0371	1.016	0004	158.6	•01:7	2.7914	.04460	85:
4+00	3065	.0336	1.359	0024	220.4	•01.1	2.6657	.03811	77
		l			1				1
10.00	2847	.0289	2.453	0052	277.5	•01.3	2.4459	•02986	65
20.00	2692	•0251	4.076	0075	311.1	•01(7 •01(6	2.2431	.02398 .02381	554
20.41	2587	•0250	4.140 5.959	0075 0100	312.0	•01(0	2.0143	•01851	45
40.00	2742	•0209	0.777	0100	337.4	-0110	140143	.01021	
100.00	2349	.0144	14.469	0141	370.9	•00°2	1.6831	.01209	320
200.00	2203	·0084	25.445	0180	391.3	•00₺5	1.4246	.00801	226
400.00	2052	-0014	44.925	0228	409.3	•0077	1.1770	+00475	144
				-			ŀ		
1000.00	1839	0094	95.113	0303	429.9	•00€7	.8997	-00185	- •06
2000 • CC	1668	0171	166.760	0360	443.3	•0058	• 7520	•00070	- •026
4000.00	1493	0227	290+406	-•0400	455.0	•0050	•6606	+00020	- •008
		R = 1+	50. PERC	ENT FUEL	= 7.7	4. Q/F	= 1.905		
		1			T			0.03076	-0.592
1.00	3297	0.0338	9,192	0+0017	37.9	0.01:5	1.8003	0.03075	58
1.05	3282	•0335 •0327	2.123	•0012	75.0	•01/4	1.7680	•02902	568
1.20	3198	.0318	1.052	•0007	98.7	.01:2	1.7391	.02758	548
1.50	3159	.0309	1.005	•0003	116.2	-01.0	1.7131	.02635	53
1.73	3137	•0304	1.000	•0000	125.0	.01.0	1.6977	.02565	52
2.00	3096	•0295	1.015	-+0005	140.2	•01(8	1.6672	+02432	50
4.00	2904	•0249	1.354	0031	194.6	•01(0	1.5078	.01834	405
	1					_			
10.00	2661	.0179	2.427	0071	244.6	•0019	1.2677	.01140 .00711	276
20.00	2478	.0118 .0116	3.997 4.058	0108	273.8	•00 € 0	1.0774	•00711	186
20.41 40.00	2291	•0050	6.734	0110	298.2	•00:1	8963	.00387	112
40.00		10020	01,34	10121	.,	100.1	1	10011	
100.00	2032	0040	13.621	0211	324.8	+0059	•7030	-00129	- •043
200.00	1830	0093	23.271	0245	341.5	•00-9	•6070	●00043	016
400.00	1629	0125	39.732	0264	355.8	•00+1	•5500	•00011	- •00
1000.00	1379	0144	80.499	0273	371.5	•00:2	•5072	•00001	- •000
2000+10	1207	0152 0159	137.214 233.567	0276 0278	381.4	•00.7 •00.4	•4850 •4650	•00000	- •000
4000-00	1000	.0.57	233,00	102.0	,,,,,,			1	
	,	R = 2+	DO. PERC	ENT FUEL	= 5.9	2 , U, F	= 5.873		.
1.00	3103	0.0262					1.2138	0.01648	-0.347
						0-0014			
1.05	3088	•0258	2.129	0.0020	34.7	0.0013	1.2052	•01611	341
1.05	3046	•0249	1.243	•0015	66.7	•00°∠	1.1812	•01513	34 32
1.05 1.20 1.40	3046 2998	•0249 •0237	1.243	•0009	66.7 90.2	• 00, 0 • 00, 7	1.1812	•01513 •01402	32
1.05 1.20 1.40 1.60	3046 2998 2957	•0249 •0237 •0228	1.243 1.053 1.006	•0015 •0003	66.7 90.2 106.2	•00; 8 •00; 0 •00; 7	1.1812 1.1528 1.1276	.01513 .01402 .01309	325 301 291
1.05 1.20 1.40 1.60 1.73	3046 2998 2957 2932	•0249 •0237 •0228 •0222	1.243 1.053 1.006 1.000	•0015 •0009 •0003 •0000	66.7 90.2 106.2 114.7	•00° 2 •00° 0 •00! 8 •00! 7	1.1812 1.1528 1.1276 1.1122	•01513 •01402 •01309 •01255	325 307 297 287
1.05 1.20 1.40 1.60 1.73 2.00	3046 2998 2957 2932 2889	.0249 .0237 .0228 .0222 .0211	1.243 1.053 1.006 1.000 1.014	•0015 •0009 •0003 •0000 -•0006	66.7 90.2 106.2 114.7 128.2	.00° 2 .00° 0 .00° 8 .00° 7	1.1812 1.1528 1.1276 1.1122 1.0844	.01513 .01402 .01309 .01255	325 307 297 287 265
1.05 1.20 1.40 1.60 1.73	3046 2998 2957 2932	•0249 •0237 •0228 •0222	1.243 1.053 1.006 1.000	•0015 •0009 •0003 •0000	66.7 90.2 106.2 114.7	•00° 2 •00° 0 •00! 8 •00! 7	1.1812 1.1528 1.1276 1.1122	.01513 .01402 .01309 .01255 .01160 .00749	325 307 297 287 265
1.05 1.20 1.40 1.60 1.73 2.00	3046 2998 2957 2932 2889	.0249 .0237 .0228 .0222 .0211	1.243 1.053 1.006 1.000 1.014 1.344	.0015 .0009 .0003 .0000 0006 0038	66.7 90.2 106.2 114.7 128.2 177.5	-00° 2 -00° 0 -001 8 -001 7 -001 5 -00° 5	1.1812 1.1528 1.1276 1.1122 1.0844 .9449	.01513 .01402 .01309 .01255 .01160 .00749	325 30 29 28 265 186
1.05 1.20 1.40 1.60 1.73 2.00 4.00	3046 2998 2957 2932 2889 2679 2402 2188	.0249 .0237 .0228 .0222 .0211 .0155 .0076 .0017	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861	.0015 .0009 .0003 .0000 0006 0038 0086 0123	66:7 90:2 106:2 114:7 128:2 177:5	-00° 2 -00° 0 -001 8 -001 7 -001 5 -00° 5	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644	.01513 .01402 .01309 .01255 .01160 .00749 .00348	325 291 281 265 186 099 051
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.00 20.41	3046 2998 2957 2932 2889 2679 2402 2188 2181	.0249 .0237 .0228 .0222 .0211 .0155 .0075 .0017	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861 3.918	.0015 .0009 .0003 .0000 0006 0038 0123 0124	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2	-00° 2 -00° 0 -001 8 -001 7 -001 5 -001 3 -001 3	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00160 .00156	325 307 291 265 186 095 055
1.05 1.20 1.40 1.60 1.73 2.00 4.00	3046 2998 2957 2932 2889 2679 2402 2188	.0249 .0237 .0228 .0222 .0211 .0155 .0076 .0017	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861	.0015 .0009 .0003 .0000 0006 0038 0086 0123	66:7 90:2 106:2 114:7 128:2 177:5	-00° 2 -00° 0 -001 8 -001 7 -001 5 -00° 5	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644	.01513 .01402 .01309 .01255 .01160 .00749 .00348	325 307 291 265 186 095 055
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.00 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970	.0249 .0237 .0228 .0221 .0155 .0076 .0017 .0015	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385	.0015 .0009 .0009 .0000 -0006 -0038 -0086 -0123 -0124 -0153	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8	• 00° 2 • 00° 0 • 008 7 • 00° 5 • 00° 5 • 00° 3 • 00° 2 • 00° 3	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00160 .00156	325 307 297 287 265 186 095 057 057
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.00 20.41 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686	.0249 .0237 .0228 .0222 .0211 .0155 .0075 .0017 .0015 -0031	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385	.0015 .0009 .0003 .0000 0006 0038 0123 0124 0153	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8	• 00° 2 • 00° 0 • 00° 8 • 00° 7 • 00° 5 • 00° 3 • 00° 2 • 00° 3	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00160 .00156	325 307 291 265 186 050 050
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.00 20.41 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483	.0249 .0237 .0228 .0222 .0211 .0155 .0076 .0017 .0015 -0031	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385	-0015 -0009 -0000 -0006 -0038 -0023 -0124 -0153 -0174 -0179	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8	.00° 2 .00° 0 .001 8 .002 7 .001 5 .001 5 .001 3 .001 2 .001 3	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447	.01513 -01402 -01309 -01255 -01160 -00749 -00348 -00156 -00056 -00060	325 291 265 186 095 050 021
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.00 20.41 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686	.0249 .0237 .0228 .0222 .0211 .0155 .0075 .0017 .0015 -0031	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572	.0015 .0009 .0003 .0000 0006 0038 0123 0124 0153	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8 292.5 306.5 318.2	• 00° 2 • 00° 0 • 00° 8 • 00° 7 • 00° 5 • 00° 3 • 00° 2 • 00° 3	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .5611	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00160 .00156	325 307 297 287 265 186 095 057 057
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.01 40.00 10.00 20.41 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483	.0249 .0237 .0228 .0222 .0211 .0155 .0076 .0017 .0015 -0031	1.243 1.003 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572	-0015 -0009 -0000 -0006 -0038 -0086 -0123 -0124 -0153 -0174 -0179 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8	• 00° 2 • 00° 0 • 00° 8 • 00° 7 • 00° 5 • 00° 5 • 00° 3 • 00° 2 • 00° 3 • 00° 3 • 00° 6 • 00° 1	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .5611	.01513 -01402 -01309 -01255 -01160 -00749 -00348 -00156 -00056 -00060	325 291 265 186 095 050 021
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.00 20.41 40.00 100.00 200.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297	.0249 .0237 .0228 .0222 .0211 .0155 .0076 .0015 -0031 0068 0066 0086	1.243 1.003 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641	-0015 -0009 -0000 -00006 -0038 -0123 -0124 -0153 -0174 -0179 -0160	66-7 90-2 106-2 114-7 128-2 177-5 222-6 248-5 249-2 265-8 292-5 306-5 318-2	.00° 2 .00° 0 .00° 8 .00° 7 .00° 5 .00° 3 .00° 3 .00° 2 .00° 3 .00° 3 .00° 4	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .5611 .4923 .4427 .4427	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00156 .00056 .00060 .00012 .00000 .00000	325 497 291 265 186 095 051 005 001 005 001 000 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.41 40.00 100.00 20.00 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297	.0249 .0237 .0228 .0222 .0211 .0155 .0075 .0017 .0015 -0031 -0068 -0060 -0086	1.243 1.003 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572	-0015 -0009 -0000 -0006 -0038 -0086 -0123 -0124 -0153 -0174 -0179 -0180	66-7 90-2 106-2 114-7 128-2 177-5 222-6 248-5 249-5 306-5 318-2 331-0	• 00° 2 • 00° 0 • 00° 8 • 00° 7 • 00° 5 • 00° 5 • 00° 3 • 00° 2 • 00° 3 • 00° 3 • 00° 6 • 00° 1	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4632 .4427	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00160 .00156 .00060 .00012 .00003 .00000	325 497 291 265 186 095 051 005 001 005 001 000 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.41 40.00 100.00 20.00 40.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297	.0249 .0247 .0248 .0222 .0211 .0155 .0075 .0015 -0031 -0068 -0060 -0086	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392	-0015 0009 0003 00000 -0006 -0038 -0123 -0124 -0153 -0174 -0179 -0180 -0180 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8 292.5 306.5 318.2 331.0 338.9 349.5	.001 2 .001 0 .001 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .5611 .4923 .4427 .4427	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00156 .00056 .00060 .00012 .00000 .00000	325 497 291 265 186 095 051 005 001 005 001 000 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 20.00 20.41 40.00 100.00 200.00 400.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 9797	.0249 .0247 .0228 .0222 .0211 .0155 .0017 .0015 -0031 0068 0092 0095 .0099 R = 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392	-0015 0009 0003 00000 -0006 -0038 -0123 -0124 -0153 -0174 -0179 -0180 -0180 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8 292.5 306.5 318.2 338.9 345.5	.001 2 .001 0 .001 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .5611 .4923 .4632 .4427 .4201 .4046 .3700	.01513 .01402 .01309 .01255 .01160 .00749 .00348 .00160 .00015 .00060 .00012 .00003 .00000 .00000	32'30'29'28'28'28'28'28'28'28'29'29'29'29'29'29'29'29
1.05 1.20 1.40 1.40 1.73 2.00 4.00 20.00 20.41 40.00 20.00 40.00 200.00 40.00 200.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 929 797	.0249 .0249 .0248 .0228 .0211 .0155 .0017 .0015 -0011 -0068 -0086 -0092 -0099 R = 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392	-0015 -0009 -0003 -0006 -0008 -0025 -0124 -0153 -0124 -0179 -0180 -0180 -0180 -0182	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8 292.5 306.5 318.2 331.0 349.5 349.	.001 2 .001 0 .001 8 .001 7 .001 5 .001 3 .001 3 .001 3 .001 3 .001 3 .001 6 .001 1	1.1812 1.1528 1.1276 1.1127 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4032 .4427 .4201 .4006 .37900 = 3.810	0.1013 0.1402 0.1309 0.1255 0.1160 0.0749 0.0348 0.0156 0.0015 0.0003 0.0000 0.0000 0.0000	321 301 281 265 186 055 055 002 000 000 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 20.01 10.00 20.41 40.00 100.00 200.00 400.00 100.00 2000.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 929 797	0.029 0.029 0.022 0.022 0.021 0.015 0.0075 0.0015 0080 0080 0080 0092 0095 0095 0091	1.243 1.053 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392	-0015 -0009 -0003 -0000 -0008 -0026 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0180	66.7 90:2 106:2 114:7 128:2 177:5 222:6 248:5 249:8 292:5 306:5 318:2 331:0 338:5 = 4:0	.001 2 .001 0 .001 8 .002 7 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 1	1.1812 1.1528 1.1276 1.1127 1.0844 .9449 .7644 .6477 .5611 .4923 .4632 .4427 .4201 .4046 .3700 = 3.810 0.65909 .6842	0.1013 0.1402 0.1309 0.1259 0.1160 0.0749 0.0348 0.00156 0.00156 0.0000 0.00000 0.00000 0.00000	322 300 281 286 186 055 055 056 001 000 000 000 000
1.05 1.20 1.40 1.40 1.73 2.00 4.00 20.00 20.41 40.00 200.00 40.00 200.00 400.00	3046 2998 2957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 929 797 2723 2705 2658	0.249 0.249 0.228 0.222 0.211 0.155 0.0017 0.0015 -0.0080 -0.0086 -0.0095 -0.0099 -0.0099 -0.0099	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392	-0015 -0009 -0003 -0006 -0008 -00185 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0180 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.5 306.5 318.2 331.0 338.9 345.5	.001 2 .001 0 .001 8 .001 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 3 .001 6 .001 1	1.1812 1.1528 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4427 .4201 .4046 .3700 = 3.810 0.6909 .6659	0.00463 .004045 .00000 .00000 .00000 .00000 .00000 .00000 .00000	322 400 201 201 205 005 005 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 20.01 40.00 100.00 200.00 400.00 100.00 200.00 400.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00	3046 2998 2997 2937 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 929 797	.0249 .0247 .0248 .0222 .0211 .0155 .0017 .0015 -0091 -0098 -0098 -0099 -0099 -0095 -0095 -0015 -0132 .0122	1.243 1.005 1.006 1.0000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC	.0015 .0009 .0003 .0000 -0006 -0038 -00183 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0180 -0192	66.7 90.2 106.2 114.7 128.2 177.5 222.6 249.2 265.8 292.5 318.2 331.0 338.9 345.5 58.6 30.5 58.6 79.2	.001 2 .001 0 .001 8 .002 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .000 1 .000 4 .000 4 .000 4 .000 5	1.1812 1.1528 1.1276 1.1127 1.0844 .9449 .7644 .6477 .5611 .4923 .4627 .4201 .4046 .3700 0.6909 .68659 .6659	0.1513 0.1402 0.1309 0.1255 0.1160 0.0749 0.0348 0.0156 0.0056 0.0056 0.0060 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	322 300 291 286 186 056 057 005 006 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.41 40.00 100.00 200.00 400.00 100.00 200.00 400.00	3046 2998 2997 29957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 929 797	.0249 .0249 .0228 .0228 .0222 .0211 .0155 .0017 .0015 -0031 -0068 -0096 -0096 -0099 R = 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC	-0015 -0009 -0003 -0006 -0038 -0018 -0124 -0153 -0124 -0179 -0180 -0	66.7 90.2 106.2 114.7 128.2 177.5 222.6 248.5 249.2 265.8 292.9 306.9 318.9 340.9 30.5 58.6 79.2 93.1	.001 2 .001 0 .001 8 .002 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 6 .001 1	1.1812 1.1528 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4427 .4201 .4046 .3700 = 3.810 0.6909 .6659	0.1013 0.1402 0.1309 0.1255 0.1160 0.0749 0.0348 0.0160 0.0156 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	- 322 - 281
1.05 1.20 1.40 1.60 1.60 2.00 20.41 40.00 10.00 20.41 40.00 10.00 20.00 10.00 20.00 10.00 20.00 10.00	3046 2998 2997 2937 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 9797	0.249 .0247 .0228 .0222 .0221 .0155 .0017 .0015 -0008 -00080 -00080 -0092 -0095 -0099 -0099 -0192 .0192 .0192 .0192 .0193	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC	.0015 .0009 .0003 .0000 -0006 -0038 -00183 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0180 -0192	66.7 90.2 106.2 114.7 128.2 177.5 222.6 249.2 265.8 292.5 318.2 331.0 338.9 345.5 58.6 30.5 58.6 79.2	.001 2 .001 8 .001 7 .001 8 .001 7 .001 5 .001 5 .001 3 .001 2 .001 3 .001 6 .001 1 .001 4 .001 3 .001 4 .001 3 .001 4 .001 3 .001 6 .001 1 .001 6 .001 1 .001 6 .001 1	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4427 .4201 .4046 .3700 0.6909 .6659 .6659 .6659	0.1513 0.1402 0.1309 0.1255 0.1160 0.0749 0.0348 0.0156 0.0056 0.0056 0.0060 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	- 322 - 281
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.41 40.00 100.00 200.00 400.00 100.00 200.00 400.00	3046 2998 2997 29957 2932 2889 2679 2402 2188 2181 1970 1686 1483 1297 1076 929 797	0.249 .0249 .0228 .0228 .0222 .0211 .0155 .0017 .0015 -0031 -0068 -0096 -0095 -0099 R = 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC	.0015 .0009 .0003 .0000 -0006 -0038 -0123 -0124 -0179 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0190	66.7 90.2 106.2 114.7 128.2 177.5 222.6 2249.2 265.8 292.5 306.5 318.2 331.0 338.9 345.5 = 4.0	.001 2 .001 0 .001 8 .002 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 6 .001 1	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .76447 .6477 .6477 .6463 .4923 .4032 .4427 .4201 .4046 .3900 .6659 .6659 .6659 .6451 .6275	0.1513 0.1402 0.1309 0.1255 0.1160 0.0749 0.0348 0.00156 0.00156 0.0000 0.00	- 322 - 281
1.05 1.20 1.40 1.60 1.73 2.00 20.00 20.41 40.00 100.00 20.00 200.00 400.00 100.00 2000.00 2000.00 4000.00	3046 2998 2997 2998 2957 2989 2679 2402 2188 11970 1686 1489 1297 1076 929 797 797	.0249 .0247 .0228 .0222 .0211 .0155 .0017 .0015 -00031 -0068 -0080 -0092 -0095 -0099 R - 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 2.148 1.252 1.058 1.008 1.000 1.012 1.317	-0015 -0009 -0003 -0006 -0008 -0018 -0018 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0180 -01904 -0006 -0004	66.7 90.2 106.2 114.7 128.2 177.5 222.6 228.5 249.2 265.8 292.5 306.5 318.9 338.9 345.5 = 4.0	.001 2 .001 8 .001 7 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1 .001 6 .001 6 .0	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4427 .4201 .4046 .3700 .3810 .4659 .6659 .6659 .6451 .6275 .5991 .5216	0.1013 0.1402 0.1309 0.1259 0.1160 0.0749 0.0348 0.0016 0.0016 0.0006 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	- 322 - 300 - 294 - 265 - 186 - 055 - 005 - 000 -
1.05 1.20 1.40 1.60 1.73 2.00 20.40 20.40 20.40 40.00 40.00 40.00 40.00 40.00 1.00 40.00 1.00 1	2998 2998 2997 2998 2679 2402 2188 2181 1970 1688 1297 1076 929 797 2723 2705 2658 2604 2526 2523 2477 2232 1914	0.249 0.249 0.228 0.222 0.211 0.155 0.0077 0.015 -0.0080 -0.0080 -0.0095 -0.0099 -0.0136 0.0136	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC	-0015 -0009 -0003 -0006 -0008 -0015 -0124 -0153 -0124 -0179 -0180	66.7 90.2 106.2 1148.2 1177.5 222.6 228.6 228.5 249.2 265.8 306.5 318.2 331.0 338.9 345.5 = 4.0	000 2 001 8 001 7 001 5 001 5 001 5 001 3 001 2 001 2 001 3 001 6	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4427 .4201 .4046 .3700 2.3810 0.6909 .6859 .6451 .6275 .591 .5216 .4517	0.01913 0.1402 0.1309 0.1255 0.01749 0.0348 0.0106 0.01156 0.00000 0.00000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	322926
1.05 1.20 1.40 1.60 2.00 20.00 20.00 20.00 20.00 40.00 40.00 1000.00 2000.00 4000.00 1.00 4.00 1.00 1	3046 2998 29957 29957 2889 2679 2402 2188 2181 1970 1076 929 797 1076 2658 2523 2477 2232 1914 1684	.0249 .0247 .0248 .0222 .0211 .0155 .0017 .0015 -00031 -0068 -0080 -0092 -0095 -0099 R = 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 119.641 201.392 00. PERC	-0015 -0009 -0008 -0008 -0018 -0018 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0192 ENT FUEL	66.7 90.2 106.2 114.7 128.2 177.5 222.6 2248.5 249.2 265.8 292.5 306.5 318.2 331.0 338.9 345.5 = 4.0 30.5 58.6 79.2 93.1 101.6 112.2 1154.7	.001 2 .001 8 .001 9 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1 .001 0 .0	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .4923 .4032 .4227 .4201 .4046 .3700 .3810 .6659 .6451 .6275 .6155 .5991 .5216	0.1013 0.1402 0.1309 0.1259 0.1160 0.0749 0.0348 0.0016 0.0016 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	- 322 - 300 - 249 - 261 - 186 - 051 - 000 -
1.05 1.20 1.40 1.60 1.73 2.00 20.40 20.40 20.40 40.00 40.00 40.00 400.00 1.05 1.20 1.40 1.65 1.20 1.76 2.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 2.00 1.00 1	2998 2957 2932 2869 2679 2402 2108 2108 2108 11970 1076 6929 797 2723 2703 2705 2658 2658 2523 2723 273 273 2705 273 274 275 275 275 275 275 275 275 275 275 275	0.249 .0249 .0228 .0228 .0221 .0155 .0017 .0015 .0016 .0080 .0086 .0095 .0099 .0126	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 319.641 201.392 00. PERC 2.148 1.252 1.058 1.000 1.012 1.317	-0015 -0009 -0008 -0008 -0018 -0018 -0124 -0153 -0124 -0159 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 228.5 249.2 265.8 292.5 318.2 331.0 338.9 349.5 = 4.0 30.5 58.6 79.2 93.1 101.6 112.2 154.7	.001 2 .001 0 .001 8 .002 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1 .001 6 .001 1 .001 6 .001 1 .001 8 .001 5 .001 5	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .9611 .4923 .4427 .4201 .4046 .3790 .3790 .6659 .6659 .6651 .6275 .6155 .5991 .5216	0.01513 0.1402 0.1309 0.1250 0.01160 0.00749 0.0348 0.00160 0.0015 0.00003 0.000000	- 322 - 300 - 29 - 26 - 186 - 05 - 05 - 002 - 000
1.05 1.20 1.40 1.60 2.00 20.00 20.00 20.00 20.00 40.00 40.00 1000.00 2000.00 4000.00 1.00 4.00 1.00 1	3046 2998 29957 29957 2889 2679 2402 2188 2181 1970 1076 929 797 1076 2658 2523 2477 2232 1914 1684	.0249 .0247 .0248 .0222 .0211 .0155 .0017 .0015 -00031 -0068 -0080 -0092 -0095 -0099 R = 3.	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 119.641 201.392 00. PERC	-0015 -0009 -0008 -0008 -0018 -0018 -0124 -0153 -0174 -0179 -0180 -0180 -0180 -0192 ENT FUEL	66.7 90.2 106.2 114.7 128.2 177.5 222.6 2248.5 249.2 265.8 292.5 306.5 318.2 331.0 338.9 345.5 = 4.0 30.5 58.6 79.2 93.1 101.6 112.2 1154.7	.001 2 .001 8 .001 9 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1 .001 0 .0	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .4923 .4032 .4227 .4201 .4046 .3700 .3810 .6659 .6451 .6275 .6155 .5991 .5216	0.1013 0.1402 0.1309 0.1259 0.1160 0.0749 0.0348 0.0016 0.0016 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00	- 322 - 300 - 29 - 26 - 186 - 05 - 05 - 002 - 000
1.05 1.20 1.40 1.60 1.73 2.00 4.00 10.00 20.41 40.00 10.00 20.40 20.00 400.00 1000.00 2000.00 400.00 1.00 1.00 1.00 1.00 1.00 1	2998 2997 2998 2679 2407 2402 2188 2181 1970 1076 1483 1297 1076 6929 797 797 2723 2407 2556 2523 2477 2232 1914 1644 1678 1472	0.249 .0249 .0248 .0228 .0221 .0155 .0017 .0015 -0031 -0068 -0096 -0095 -0099 R = 3. 0.0156 .0152 .0122 .0116 .0159 .0159 .0159 .0099	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 319.641 201.392 00. PERC 2.148 1.252 1.058 1.008 1.000 1.012 1.317 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 3	-0015 -0009 -0008 -0008 -0018 -0018 -0124 -0153 -0124 -0159 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 228.6 228.5 249.2 265.8 306.5 318.2 331.0 338.9 58.6 79.2 93.1 101.6 112.2 154.7	.001 2 .001 0 .001 8 .002 7 .001 5 .001 3 .001 3 .001 2 .001 3 .001 2 .001 3 .001 4 .001 1 .001 6 .001 1 .001 6 .001 1 .001 8 .001 5 .001 5	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .9611 .4923 .4427 .4201 .4046 .3790 0.6909 .6659 .6451 .6275 .6155 .5991 .5216 .4517 .4204	0.0163 0.0160 0.00749 0.00749 0.00348 0.00160 0.00160 0.00160 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.000000 0.00000000	32292926
1.05 1.20 1.40 1.60 1.60 1.73 2.00 4.00 10.00 20.01 40.00 10.00 20.00 100.00 2000.00 1.00 1.0	2998 2997 2998 2679 2402 2402 2108 2108 11970 1686 1483 1297 1076 929 797 2773 2773 2773 2773 2773 2773 2	.0249 .0249 .0247 .0248 .0222 .0211 .0155 .0017 .0015 .0092 .0099 .0099 .0099 .0099 .0122 .0112 .0112 .0122 .0123 .0093	1.243 1.005 1.006 1.0000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC 2.148 1.252 1.058 1.008 1.000 1.012 1.317 2.414 1.414	-0015 -0003 -0006 -0008 -0018 -0018 -0124 -0153 -0174 -0179 -0180	66.7 90.2 106.2 114.7 128.2 177.5 222.6 222.6 224.6 294.2 331.0 338.9 340.5 30.5 58.6 79.2 93.1 101.6 112.2 112.2 112.2 112.3 112.6 213.8 2248.6	.001 2 .001 8 .001 8 .001 7 .001 5 .001 5 .001 3 .001 2 .001 3 .001 6 .001 1 .001 3 .001 4 .001 3 .001 4 .001 3 .001 4 .001 3 .001 5 .001 3 .001 6 .001 1 .001 6 .001 1 .001 6 .001 1 .001 6 .001 1 .001 6 .001 7 .001 6 .001 7 .001 7 .001 7 .001 7	1.1812 1.1528 1.1276 1.1122 1.0844 9449 7.6447 .5611 .4923 .4032 .4427 .4201 .4046 .3700 0.6659 .6451 .6275 .6155 .5991 .5216 .4207 .4204	0.01513 0.1402 0.1309 0.1255 0.1160 0.0749 0.0348 0.0010 0.0015 0.00000	32292826
1.05 1.20 1.40 1.60 1.60 2.00 20.00 20.41 40.00 100.00 200.00 400.00 100.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00 1.	2998 2997 2998 2679 2402 2402 2108 2108 11970 1076 1483 1297 1076 929 797 797 22556 2523 2404 1684 1684 1684 1684 1684 1684 1684 168	0.249 0.247 0.228 0.222 0.211 0.155 0.0077 0.015 -0.0040 -0.0060 -0.0060 -0.0095 -0.0099 R = 3.0000 0.0136 0.01	1.243 1.005 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 319.641 201.392 00. PERC 2.148 1.252 1.058 1.008 1.000 1.012 1.317 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 2.261 3.580 3	-0015 -0003 -0006 -0038 -0006 -0038 -00123 -0124 -0153 -0124 -0159 -0180	66.7 90.2 104.2 105.2 114.7 128.2 177.5 222.6 228.5 249.2 265.8 292.5 306.5 318.2 331.0 338.0 338.0 338.0 338.0 338.0 101.6 110.6 110.6 112.2 154.7 192.6 213.8 214.4 230.8	.001 2 .001 8 .001 9 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 5 .0	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .9611 .4923 .4427 .4201 .4046 .3790 0.6909 .6659 .6451 .6275 .6155 .5991 .5216 .4517 .4204	0.01463 0.01463 0.01460 0.00749 0.0348 0.0166 0.0016 0.0016 0.0006 0.0000	32292826
1.05 1.20 1.40 1.60 1.60 20.01 10.00 20.04 140.00 100.00 200.00 100.00 2000.00 1.05 1.20 1.60 1.73 2.00 4.00 1.00 1.00 1.00 1.00 1.00 1.00 1	2998 2997 2998 2679 2402 2402 2108 2108 11970 1686 1483 1297 1076 929 797 2773 2773 2773 2773 2773 2773 2	.0249 .0249 .0247 .0248 .0222 .0211 .0155 .0017 .0015 .00080 .00080 .00080 .00092 .0099 .0099 .0099 .0122 .0112 .0112 .0120 .0083 .0	1.243 1.003 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC 2.148 1.252 1.058 1.000 1.012 1.317 2.261 3.580 2.163 1.000 1.012 1.317 2.261 3.580 2.177 1.317 2	-0015 -0009 -0003 -0006 -0038 -0008 -0018 -0124 -0153 -0124 -0159 -0180	66.7 90.2 104.2 105.2 114.7 128.2 177.5 222.6 228.5 249.2 265.8 306.5 318.2 331.0 338.0 338.0 338.0 338.0 338.0 318.2 101.6 110.6 112.2 154.7 192.6 213.8 21	.001 2 .001 0 .001 8 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 0 .0	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .6447 .4016 .4923 .4427 .4201 .4046 .3700 .4201 .6659 .6659 .6451 .6275 .6155 .5991 .6275 .6159 .6494 .7420	0.01463 0.01460 0.0156 0.00749 0.0348 0.0166 0.0016 0.0016 0.00060 0.00000	- 322 - 326 - 26 - 186 - 05 - 0
1.05 1.20 1.40 1.60 1.60 2.00 20.00 20.41 40.00 100.00 200.00 400.00 100.00 200.00 400.00 1.00 1.00 1.00 1.00 1.00 1.	2998 2997 2998 2679 2402 2402 2108 2108 11970 1076 1483 1297 1076 929 797 797 22556 2523 2404 1684 1684 1684 1684 1684 1684 1684 168	0.249 0.247 0.228 0.222 0.211 0.155 0.0077 0.015 -0.0040 -0.0060 -0.0060 -0.0095 -0.0099 R = 3.0000 0.0136 0.01	1.243 1.003 1.006 1.000 1.014 1.344 2.379 3.861 3.918 6.385 12.580 21.125 35.572 70.973 119.641 201.392 00. PERC 2.148 1.252 1.058 1.000 1.012 1.317 2.261 3.580 2.163 1.000 1.012 1.317 2.261 3.580 2.177 1.317 2	-0015 -0009 -0003 -0006 -0038 -0018 -0018 -0124 -0174 -0179 -0180	66.7 90.2 104.2 105.2 114.7 128.2 177.5 222.6 228.5 249.2 265.8 306.5 318.2 331.0 338.0 338.0 338.0 338.0 338.0 318.2 101.6 110.6 112.2 154.7 192.6 213.8 21	.001 2 .001 8 .001 9 .001 5 .001 5 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 2 .001 3 .001 5 .0	1.1812 1.1528 1.1276 1.1122 1.0844 .9449 .7644 .6477 .5611 .4923 .4427 .4201 .4046 .3700 2.8427 .4201 .4046 .3700 2.8457 .6659 .6451 .6275 .5991 .5216 .4199 .4207 .4208 .4408	0.01463 0.01463 0.01460 0.00749 0.0348 0.0166 0.0016 0.0016 0.0006 0.0000	322 300 291 281 266 186 055 055 055 050 000

TABLE III. - Continued. THERMODYNAMIC DERIVATIES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(c) Concluded. Combustion-chamber pressure, 300 pounds per square inch absolute

Pressure ratio, P _C /P	T,	Temp- erature exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat, c _p , cal/(g)(°K)	(ðin ᠓),	(ðln m (ðln T)
	°K	, n _T		[^] €	(lb)(sec)/b	n _I	cal/(g)(°K)	L'. ''	I
		R = 4.0	DO PERC	ENT FUEL	= 3.0	5. U/F	= 1.746		
1.00	2372	0.0055					0 • 4836	0.00116	-0.035
1.05	2354	•0052		0.0015	27.5	0.0022	•4796	.00109	- 0033
	2303 2244	•0045 •0037	1.262	•0006	52.9 71.4	•0021 •0019	•4689 •4574	•00091 •00074	0287
	2194	•0037	1.010	•0003	83.9	.0018	•4481	.00061	- •020.
1.78	2153	•0027	1.000	•0000	92.6	•0017	•4412	+00052	017
	2110 1859	•0022 •0004	1.009 1.294	0013	138.6	•0011	•4341 •4010	•00043 •00013	- •005
	1555	0006	2.164	-•0018	171.6	0000	.3749	•00004	- •000
	1349 1343	0007	3.426 3.474	0018	189.8	+0005	•3614 •3611	•00000 •00000	000
	1165	-•0008 -•0008	5.499	0017	204 • 2	•0003	.3499	•00000	•000
100.00	952	0009	10+472	0016	219+2	•0002	• 3352 • 3243	+00000 +00000	•000
200 • 00 400 • 00	813 690	-•0009 -•0009	17.179 28.266	0016	235.5	•0002	•3139	•00000	•000
000.00	552	0009	54+663	0016	243.2	•0001	•3012	•00000	•000
000.00	463 386	0010	89.984 147.985	0016	247.9 251.8	•0001	•2928 •2864	•00000	•000
		R = 5.0	00 PERC	ENT FUEL	- - 2•4	5. 0/5	= 9.683		
	2069	0.0018	2.189	0+0006	25+2	0.0007	0.3968	0.00027	-0.009
	2051 2000	•0016	1.270	•0004	48.5	•0007	.3893	•00020	- •007
1.40	1942	•0010	1.066	•0004	65.4	+0006	• 3835	•00015	- •005
	1893	•0008	1.011	1000	76 • 8	+0005	•3790 •3753	+00012 +00009	- +004
	1851 1813	•0005 •0005	1 • 000 1 • 007	-•0000 -•0001	92.2	•0005	•3722	•00008	- •003
	1578	•0000	1.261		126+2	•0003	- 3564	•00002	- •000
	1303 1122	0002 0002	2 • 143 3 • 342	-•0004 -•0004	155.8	+0002 +0001	•3411 •3309	•00000 •00000	- •000
20-41	1117	-•0002	3.388	0004	172.4	•0001	•3306	• 00000	•000
40.00	961	0002	5 • 330	0003	184.7	•0001	•3209	•00000	•000
100.00	777 658	0002 0002	10.066 16.399	0003	197.9	•0000	•3076 •2979	•00000 •00000	•000
400+00	554	-•0002	26.792	0003	212•0	•0000	•2887	•00000	•000
000 • 00	438 365	0002 0003	51.338 83.976	0003	218+7	•0000	•2782 •2728	•00000 •00000	•000
000.00	303	0003	137.439	~•0003	225.9	•0000	• 2693	•00000	•000
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TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(d) Combustion-chamber pressure, 600 pounds $\mathfrak per$ square inch absolute

R = 0.15, PERCENT FUEL = 45.65, O/F = 1.190	Pressure ratio, P _c /P	Temp- erature T, °K	exponent	Area ratio, E	Area- ratio exponent		exponent	Specific heat,	(din 90t)	(ðin 17),
1.00		-K	n _T	<u> </u>	ne .	(lb)(sec)/lb	r	cal/(9)(°K)	\ /1	
1-05 1164 0.000			R = 0	15. PERG	ENT FUEL	= 45.6	5. O/F	= 1.190		
1-05 1168	1.00	1183	0.0000					1.7753	0.00000	0.0000
1+00 1085 .0000 1-081 .0000 1-081 .0000 1-7472 .00000 .00000 .00000 .0000 .00000 .0000 .0000 .0000 .0000 .00000 .0000 .00000 .0000								1.7710	•00000	•0000
1-87 10.08 .0000 1-018 .0000 13-3-2 .0000 1-7216 .00000 .00000 .0000 .00000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .0000										•0000
2-00 959 -0000 1-033 -0000 171-5 -0000 1-7210 -00000 -0000	1.60	1049								•0000
10.00 643 .0000 1.974 .0000 283+1 .0000 1.6526 .00000 .000										• 0000
20-00 532 .0000 2-983 .0000 309-9 .0000 1-6249 .00000 .00000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .00				1.233						•0000
40-00 437 .0000 4-620 .0000 330-4 .0000 1-6267 .00000 0 .0 40-03 437 .0000 4-652 .0000 330-8 .0000 1-6267 .00000 0 .0 100-00 240 .0000 13-431 .0000 350-8 .0000 1-6267 .00000 0 .0 200-00 280 .0000 13-431 .0000 350-8 .0000 1-6089 .00000 .0 200-00 210 .0000 21-488 .0000 372-0 .0000 1-5558 .00000 .0 210-00 210 .0000 21-488 .0000 381-6 .0000 1-6387 .00000 .0 2000-00 142 .0000 63-572 .0000 381-6 .0000 1-6387 .00000 .0 2000-00 142 .0000 63-572 .0000 381-6 .0000 1-6387 .00000 .0 2000-00 114 .0000 100-938 .0000 391-6 .0000 1-6387 .00000 .0 2000-00 114 .0000 100-938 .0000 94-3 .0000 1-6387 .00000 .0 2-23 .0000 1-239 .0000 94-3 .0000 1-6287 .00000 1-6289 .00000 .0 2-23 .0000 1-239 .0000 94-6 .0000 1-624 .0000 .0 2-23 .0000 1-239 .0000 94-6 .0000 1-624 .0000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5388 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1-200 .0000 159-4 .0000 159-4 .0000 1-5588 .00000 .0 2-20 .0000 1079 .0000 3-049 .0000 257-2 .0000 1-5588 .00000 .0 2-20 .0000 1079 .0000 3-049 .0000 257-2 .0000 1-5588 .00000 .0 2-20 .0000 1079 .0000 3-049 .0000 257-2 .0000 1-5588 .00000 .0 2-20 .0000 1079 .0000 3-049 .0000 257-2 .0000 1-5252 .00000 .0 2-20 .0000 13-870 .0000 33-4 .0000 33-4 .00000 1-506 .00000 .0 2-20 .0000 13-870 .0000 33-4 .00000 1-506 .00000 .0 2-20 .0000 13-870 .0000 33-4 .00000 1-506 .00000 .0 2-20 .0000 13-870 .0000 33-7 .0000 1-5252 .00000 .0 2-20 .0000 13-870 .0000 33-7 .0000 13-588 .00000 .0 2-20 .0000 13-870 .0000 13-870 .0000 13-870 .00000 1-0000 1-00000 .0000 1-00000										• 000
40.83 437 .0000 4.682 .0000 330.9 .0000 1.6287 .0000000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .00000 .00000 .00000 .000000 .00000000										+0000
200-00 280 .0000 21-481 .0000 362-6 .0000 1-5951 .00000 .00000 .00000 .0000 .0000 .0000 .0000 .0000 .0000 .00000 .00000 .00000 .0000		437								•000
1000-00 230 .0000 21-488 .0000 372-0 .0000 1.5558 .00000 .0000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .0000000 .00000000										• 000
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2000-00			[1	i	i	-00000	1000
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1.00 1514 0.0000 2.233 0.0000 49.3 0.0000 1.6143 0.0000 0.0 1.20 1450 0.0000 1.289 0.0000 49.3 0.0000 1.6143 0.0000 0.0 1.20 1450 1350 0.0000 1.077 0.000 127.4 0.0000 1.5888 0.0000 0.0 1.8151 1307 0.0000 1.000 0.000 1.94. 0.0000 1.5888 0.0000 0.0 1.8151 0.0000 1.851 0.0000 1.000 0.000 1.851 0.0000 1.5851 0.0000 0.0 0.000 0.000 1.851 0.0000 1.5551 0.0000 0.0 0.0 0.000 0.0 0.0 0.0000 0.0 0.0 0.000 0.0				100-938						- 0000
1.05 1.1497		·	R = 0.	20. PERC	ENT FUEL	= 38.6	5+ 0/F	= 1.587	T	
1.20	1.00									0.0000
1.40										•0000
1.85 1307	1.40			1.077		127.4		1.5888		•0000
2000 1282 .00000 1.000 175.1 .0000 1.5584 .00000 .00000 .0000 .00000 .0000 .0000 .0000 .0000 .00000 .00000 .0000 .0000 .										•0000
10	2.00									•0000
20-00		1079				243+2		1.5046	•00000	•0000
40-00 588 -0000 4-739 -0000 348.0 -0000 1-4066 -00000 -0 40-83 585 -0000 4-802 -0000 348.6 -0000 1-4062 -00000 -0 100-00 458 -0000 8-679 -0000 348.7 -0000 1-3916 -00000 -0 200-00 379 -0000 13.870 -0000 382.7 -0000 1-3816 -00000 -0 1000-00 312 -0000 22.2766 -0000 393.0 -0000 1-3868 -00000 -0 2000-00 198 -0000 67-687 -0000 493.5 -0000 1-3684 -00000 -0 2000-00 198 -0000 67-687 -0000 493.7 -0000 1-276 -00000 -0 2000-00 198 -0000 106.754 -0000 444.6 -0000 1.276 -00000 -0 2000-00 161 -0000 106.754 -0000 444.6 -0000 1.276 -00000 -0 1-05 1797 -0001 2.218 0.0000 50-3 0.0000 1.4955 -00001 -00 1-05 1797 -0001 1.283 -0000 96.6 -0000 1.4955 -00001 -0 1-05 1797 -0001 1.283 -0000 150.7 -0000 13.6 -0000 1.4840 -00001 -0 1-60 1636 -0000 1.015 -0000 152.7 -0000 1.4840 -00001 -0 1-83 1587 -0000 1.0000 -0000 171.8 -0000 1.4494 -00000 -0 20-00 1555 -0000 1.005 -0000 124.3 -0000 1.322 -00000 -0 4-00 1322 -0000 1.256 -0000 249.3 -0000 1.3225 -00000 -0 10-00 1057 -0000 3.127 -0000 335.7 -0000 1.3225 -00000 -0 20-00 887 -0000 3.127 -0000 335.7 -0000 1.3225 -00000 -0 40.83 373 -0000 4.883 -0000 359.0 -0000 1.2550 -00000 -0 40.83 373 -0000 4.883 -0000 359.0 -0000 1.2550 -00000 -0 400.00 399 -0000 2.268 -0000 395.9 -0000 1.2550 -00000 -0 400.00 399 -0000 2.268 -0000 395.9 -0000 1.2189 -00000 -0 400.00 399 -0000 2.268 -0000 395.9 -0000 1.2189 -00000 -0 400.00 399 -0000 2.268 -0000 395.9 -0000 1.2189 -00000 -0 400.00 310 -0000 43.893 -0000 359.6 -0000 1.2189 -00000 -0 400.00 310 -0000 43.893 -0000 44.7 -0000 1.385 -00000 -00 400.00 206 -0000 1.5650 -0000 1.577 -0001 1.3967 -00000 -00 400.00 310 -0000 43.893 -0000 359.6 -0000 1.2189 -00000 -00 400.00 310 -0000 43.893 -0000 359.6 -0000 1.2189 -00000 -00 400.00 310 -0000 43.893 -0000 359.6 -0000 1.2189 -00000 -00 400.00 310 -0000 43.893 -0000 386.6 -0000 1.2189 -00000 -00 400.00 310 -0000 1.000 -0000 17.7 -0001 1.3180 -00000 -000 400.00 310 -0000 1.000 -0000 17.7 -0001 1.3180 -00000 -0000 -0000 1.2200 -0000 1.0000 -0000 1.2200 -0000 1.0000 -0000 1.2200 -0000 1.0000 -0000 1.2200 -0000 1.0000 -0										•0000
40.83										•0000
200-00 379										•0000
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1.00										•0000
1+00										-0000
1-05 1797		,	R = 0+	25, PERC	ENT FUEL	= 33.5	1. O/F	= 1.984		
1-20 1745 .0000 1-283 .0000 96.6 .0000 1-4842 .00001 00 1-60 1-60 1686 .0000 1-073 .0000 152.7 .0000 1-6712 .00001 00 1-6712 .0000 1-6712 .00001 00 1-6712 .00001 00 1-6712 .00001 00 1-6712 .00001 00 .00000 .00000 .00000 .00000 .0000 .0000 .0000 .0000 .00000 .0000 .00000 .				3 310						-0.0004
1+00 1686								1.4840		- •0004 - •0003
1.83 1587	1.40	1686	•0000	1.073	•0000	130 • 1	•0000	1.4712	•00001	- •0002
2-00 1555										- •0001
4.00 1322 .0000 1.256 .0000 249.3 .0000 1.3874 .00000 .00000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .0000000 .00000000								1.4423		0001
20							•0000			•0000
40.00 741										-0000
40.83										•0000
200.00 482 .0000 14.396 .0000 395.9 .0000 1.2189 .00000 .00 1000.00 399 .0000 23.208 .0000 406.8 .0000 1.2180 .00000 .00 1000.00 310 .0000 43.893 .0000 448.1 .0000 1.1949 .00000 .00 2000.00 256 .0000 71.279 .0000 424.7 .0000 1.1810 .00000 .00 4000.00 210 .0000 115.650 .0000 430.2 .0000 1.1855 .00000 .00 R * 0.30. PERCENT FUEL = 29.57. O/F = 2.381 1.00 2094 .0006										• 0000
1.00		301								•0000
1000+00 310 +0000 43.893 +0000 418-1 +0000 1+19-9 +00000 +00 2000+00 256 +0000 71.279 +0000 424-7 +0000 1+1810 +00000 +00 4000+00 210 +0000 115-650 +0000 424-7 +0000 1+1810 +00000 +00 4000+00 210 +0000 115-650 +0000 424-7 +0000 1+1810 +00000 +00 R * 0-30, PERCENT FUEL * 29.57, O/F * 2.381 1+00 2094										•0000 •0000
2000-00 256 -0000 11-855 -0000 424-7 -0000 1-1810 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -000000 -000000 -00000 -00000 -00000 -00000 -00000 -00000 -000000 -00000 -00000 -00000 -00000 -00000 -00000 -0000000 -00000000	1000 00	210								•0000
R = 0.30, PERCENT FUEL = 29.57, O/F = 2.381	2000•00	256	•00C3	71.279	•0000	424.7	•0000	1.1810	•00000	• 0000
1.00	+000+00	210							• 00000	• 0000
1-05 2073 -0005 2-206 0-0002 56.8 0-0002 1-4997 -00009 -001		200		JU, PERC	LIFE FUEL	- 27.0	7 3/5			
1.20 2016 .0004 1.277 .0001 97.5 .0002 1.3957 .00007 -001 1.40 1898 .0003 1.071 .0001 131.4 .0002 1.3955 .00005 - 001 1.40 1898 .0002 1.013 .0000 154.2 .0001 1.3766 .00003 - 00 2.00 1809 .0001 1.006 .0700 165.1 .0001 1.3519 .0000 - 000 4.00 1553 .0000 1.266 -0001 252.6 .0001 1.2396 .0000 - 00 20.00 1064 0001 3.206 .0000 341.7 .0000 1.1891 .00000 .00 40.83 891 0001 5.106 .0000 366.0 .0000 1.1522 .00000 .00 40.00 895 0001 5.037 .0000 366.0 .0000 1.1531 .00000 .00 200.00 590				2-206	0.0002	50.B	0.0002			-0.0027
1.40 1952 .0003 1.071 .0001 131.4 .0002 1.3825 .00003 001 1.40 1898 .0002 1.013 .0000 152.7 .0001 1.3766 .00003 001 2.00 1809 .0001 1.006 .0000 165.1 .0001 1.3519 .00002 001 4.00 1553 .0000 1.266 0001 252.6 .0001 1.2391 .00000 0001 10-00 1257 .0000 2.085 0001 310.4 .0000 1.2336 .0000 0000 20-00 1664 0001 3.206 .0000 341.7 .0000 1.1891 .00000 .00 40.83 891 0001 5.037 .0000 366.6 .0000 1.1522 .0000 .00 100.00 707 0001 9.324 .0000 390.5 .0000 1.1174 .00000 .00 200.00 590 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td>97.5</td> <td></td> <td>1.3967</td> <td></td> <td>- •0019</td>						97.5		1.3967		- •0019
1.62 1847	1.40		•0003	1.071	•0001	131.4		1.3825	•00005	- +0013
2-00										- +0010
10-00 1257 -0000 2-085 0001 310-4 -0000 1-2336 -0000 -0000 20-00 1064 0001 3+206 -0000 341-7 -0000 1-1891 -0000 -0000 40-83 891 0001 5-106 -0000 366-6 -0000 1-1522 -00000 -00 40-00 895 0001 5-037 -0000 366-6 -0000 1-1521 -00000 -00 100-00 707 0001 9-324 -0000 390-5 -0000 1-1174 -00000 -00 200-00 590 0001 14-993 -0000 404-8 -0000 1-1007 -00000 -00 400-00 490 0001 24-234 -0000 416-3 -0000 1-0867 -00000 -00	2 • 00	1809	-0001	1.006	•0000	165.1	• 0001	1.3519	•00002	- •0006
20-00 10640001 3-206 +0000 341-7 +0000 1-1891 +00000 +00 40-83 8910001 5-106 +0000 366-6 +0000 1-1522 +00000 +00 40-00 8950001 5-037 +0000 366-6 +0000 1-1531 +00000 +00 40-00 40-000 1-1531 +00000 +00 40-000 1-1531 +00000 +00 400-000 1-1007 +00000 +00 400-000 490 4900001 14-993 +0000 404-8 +0000 1-1007 +00000 +00 400-000 490 4900001 24-234 +0000 416-3 +0000 1-0867 +00000 +00 400-0000 490 4900001 24-234 +0000 416-3 +00000 1-0867 +00000 +00 400-0000 490 4900001 24-234 +0000 416-3 +00000 1-0867 +00000 +00000 +00000 +00000 +00000000 +000000	4.00	1553	•0000	1.266	-•0001	252.6	•0001	1.2991	•00000	- •0001
40.83 891 -0001 5.106 .0000 366.6 .0000 1.1522 .00000 .00 40.00 895 -0001 5.037 .0000 366.0 .0000 1.1522 .00000 .00 100.00 707 -0001 9.324 .0000 390.5 .0000 1.107 .00000 .00 400.00 490 -0001 14.993 .0000 404.8 .0000 1.1007 .00000 .00 400.00 490 -0001 24.234 .0000 416.3 .0000 1.0867 .00000 .00			•0000	2 • 085						•0000
40.00 8950001 5.037 .0000 366.0 .0000 1.1531 .00000 .00 100.00 7070001 9.324 .0000 390.5 .0000 1.1174 .00000 .00 200.00 5900001 14.993 .0000 404.8 .0000 1.1007 .00000 .00 400.00 4900001 24.234 .0000 416.3 .0000 1.0867 .00000 .00										•0000
100-00 7070001 9-324 -0000 390-5 -0000 1-1174 -00000 -00 400-00 4900001 24-234 -0000 416-3 -0000 1-0867 -0000 -00										•0000
200.00 5900001 14.993 .0000 404.8 .0000 1.1007 .00000 .00	100.00	767				1		1.1174		
400.00 4900001 24.234 .0000 416.3 .0000 1.0867 .0000 .00										•0000 •0001
										•0000
1000+00 383 0001 45-999 +0000 428-3 +0000 1+0746 - +00000 +00	1000-00	383	0001	45.999	•0000	428.3	•0000	1.0746	•00000	•0000
2000 - 70 317 0001 74 - 912 -0000 435 - 4 -0000 1 - 0638 -00000 -00	2000 • 10	317	0001	74.912	•0000	435.4	•0000	1.0638	•00000	•0000
		262	0001	122.185		441.2		1.0534	•00000	•0000

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRESSURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(d) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute

Pressure ratio, P _C /P	Temp- erature, T, °K	Temp- erature exponent, n ₁	Area ratio, E	Area- ratio exponent, ⁿ E	Specific impulse, I, (lb)(sec)/lb	Specific- impulse exponent,	Specific heat, c _p col/(g)(°K)	(<u>ð In 201</u> (ð In P) ₇	(ðin T)
		R = 0+3	5. PERCE	NT FUEL	= 26.4	7. O/F	2.778		
	2347	0.0019					1.3691	0.00042	-0.0101
1.00 1.05	2325	.0018	2.195	0.0007	50.9	0.0007	1.3621	•00039	- •0093
1.20	2266	.0014	1.273	•0005 •0003	97•7 131•8	•0007 •0006	1.3249	•00030 •00022	- •0057
1.40 1.60	2198	.0010	1.012	•0001	154.7	•0005	1.3099	•00017	- •0044
1.81	2089	•0006	1.000	•0000	172.5	•0005 •0004	1.2974	.00013	0035
2 • 00 4 • 00	2046	0004	1.007	-•0001 -•0003	254.1	•0003	1.2291	•00002	- •0006
			2.119	0003	313.0	•0001	1.1655	•00000	• 0000
10.00 20.00	1451	0002	3.281	0003	345+1	•0001	1.1204	•00000	•0000
40.83	1045	0002 0002	5.260 5.188	0003	370·9 370·3	•0001 •0001	1.0783	•00000 •00000	•0000
40+00	1050	l			ļ	ļ	1.0365	•00000	-0000
100.00	838	0002 0002	9.676 15.626	0003	395 • B 410 • 8	•0001 •0000	1.0118	•00000	•0000
200 • 00 400 • 00	586	0002	25.350	0002	422.9	•0000	.9953	•00000	•0000
1000-00	460	0002	48.288	0002	435.5	•0000	.9789	•00000	• 0000
2000 • 00	382	0002	78.852	0002	443.1	•0000	•9692 •9590	•00000 •00000	+0000
+000-00	317	0002	128.949	-•0002					1
		R = 0.4	O PERC	ENT FUEL	= 23.9	5. 0/F	= 3.175	,	
1.00	2574	0.0046			E	0.0017	1.3697	0.00120	-0.0266
1.05	2552	.0043 .0036	2.184 1.268	•0014	50•7 97•5	•0016	1.3344	.00091	0208
1.20	2422	.0028	1.065	•0006	131.5	•0014	1.3072	•00071 •00057	0167
1.60	2363	.0023 .0018	1.011	•0002 •0000	154.5	•0013 •0012	1.2856	•00047	- •0113
1.79 2.00	2266	.0015	1.008	0002	185.7	•0011	1.2533	+00009	- •0095
4.00	1978	•0001	1.284	0009	254.4	•0007	1-1787		
10.00	1637	0005	2.150	0011	314.1	• 0004	1.1109	•000001	- •000°
20.00	1408	0005 0006	3.351 5.334	0010	346.9	•0003 •0002	1.0253	•00000	• 0000
40.00 40.83	1204	0006	5.409	0010	373 • 4	+0002	1.0242	•00000	•0000
100.00	970	0006	10.029	0009	399•1	•0002	•9767	• 00000	•0000
200.00	818	0006	16.282	0009	414.7	•0001	•9478 •9249	•00000	•0000
400.00	687	0006	26.525	0009	427.4	•0001			
1000.00	542	0006	50-761	0009	440 • 7	•0001	•9037 •8928	•00000	•0000
2000 • 00 4000 • 00	452 376	0006	83 • 105 136 • 261	0009	455.1	•0000	8835	•00000	•0000
		R = 0•	45. PERC	ENT FUEL	= 21.0	97. O/F	= 3.571		
	2772	1		1	Ī	1	1.4156	0.00266	-0.0555
1.00 1.05	2773	0.0085 .0081	2.172	0.0021	50.4	0.0031	1.4027	•00251 •00212	0527
1.20	2692	•0070	1.263	•0015 •0009	96.9	•0029 •0027	1.3686	-00174	0380
1.40 1.60	2624	•0059 •0043	1.010	. •0004	153.7	• 0025	1.3022	-00144	0322
1.78	2517	•0043	1.000	0004	169.6	•0023 •0022	1.2799	•00123 •00104	
2 • 00 4 • 00	2467	.0036	1.009	0020	253.7	•0015	1.1514	•00031	0081
	1817	0008	2.182	0026	314.1	•0009	1.0682		0012
10.00 20.00	1575	0011	3.420	0025	347.4	•0007	1.0237	•00001	
40.00	1357 1350	0012 0012	5.476 5.554	0024	375.8	•0005 •0005			
40.83				Į.				•00000	•0000
100+00	1104 937	0012	10.381	0024 0023	401.0		.8996	• 00000	•0000
400.00		0013	27.755	0023		•0002	.8727	•00000	+0000
1000.00	629	0014	53.398	0023	444.3	•0002			
2000+00	526	0014	87.714	0023	452.7		•8313 •8210		
4000•00	439	0014	144.197						
		R = 0	50. PER	CENT FUE	L = 20.	12. O/F	= 3.968		
1.00			2 1/2	0.0036	50.0	0.0047	1.5012		-0.098
1.05			2.162		96.1	+0044	1.4440	-00409	- +083
1.40	2800	•0099	1.061	•0012	129.7		1.3979		
1.77	2742		1.009			0038	1 1.3324	.0026	056
2.00	2647	•0068	1.010	0006	183.5	•0036	1.3008		
4.00			1.303						
10.00					313.1			00001	
20.00				0046	373.8	• 0005	9482	• 0000	0 - •000
40.8						•000	9 •947] :	• 0000	000
100.00	1238	0022				* 000			
200 • 00	1059	0023	17.634	0046					
400.01	900	-•0023					ı		
1000-0								3 •0000 1 •0000	0 •000
12000-0	D 606	5 →• 0023	152.84	- •00•	6 462				

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(d) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute

Pressure ratio,	Temp- erature T,	Temp- erature exponent	Area ratio,	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent	Specific heat,	(ð in TR)	(din M)
P _c /P	°K	n _T	ε	n _e	[, (B)(sec)/B	n _I	cal/ g)(°K)	(din P)	(din 1)
		R = 3.	60. PERG	ENT FUEL	= 17.3	5. Q/F	= 4.762		
1.00	3208	0.0226		T -			1.7671	0.01310	
1.05	3189	•0221	2.144	0.0028	48.8	0.0078	1.7482	0.01210 -01170	-0.228
1.20	3137	•0208	1.250	•0021	93.8	•0075	1.6966	-01063	204
1.40	3077	•0192 •0178	1.057	•0013 •0005	149.1	•0073 •0070	1.5869	+00947 +00852	1854
1.75	2990	.0169	1.000	•0000	162.3	•0069	1.5531	•00791	- +1588
2.00	2938	•0155	1.012	0008	179.7	•0066	1.5041	•00705	1436
4.10	2669	•0083	1.323	0048	248.0	•0054	1.2723	•00352	- •0779
10.00	2313	•0006	2.288	0091	309.3	•0039	1.0538	•00101	- •0253
20+00 40+00	2050	0027 0041	3.644 5.926	0108 0113	343.7	•0030	•9574 •8996	•00029	- •008
40.83	1796	0041	6.013	0113	372.3	•0023 •0023	·8983	•00006	0019
100.00	1506	- 2267	11.474						
200.00	1306	0047	19.054	0112 0111	400.7	-0017 -0013	•6482 •6136	•00000	•0004
400.00	1125	0052	31.724	0110	433.1	•0011	• 7807	•00000	•0000
1000-00	916	- 0051	4 4 2 76	,, _	448.6		7. 0		
2000.00	778	0055	103.640	0110	448.8	•0008 •0007	•7420 •7177	•00000	•0000
4000.00	658	0058	172.288	0111	466.4	•0005	6983	•00000	•0000
		R = 0.	70. PERC	ENT FUEL	= 15.2	5 0/F	. 5.556	•	1
1.00	3381	0.0307						0.03486	0 6146
1.05	3364	• 0303	2.133	0+0024	47.4	0.0103	2.1301 2.1115	0.02284	-0.4169
1.20	3317	•0291	1.245	+0018	91.2	•0101	2.0594	•02085	3876
1.40	3263	•0278 •0266	1.054	+0011	123.3 145.2	+0098	1.9976	•01921	3626
1.74	3188	. 0258	1.000	+0004	157.0	•0096 •0095	1.9428	•01783 •01699	3412
2.00	3140	.0245	1.014	0007	175.1	•0093	1.8496	-01560	305
4.00	2903	•0173	1.339	-•0047	242.3	•0082	1.5556	•00954	2006
10.00	2584	•0070	2.356	0106	303.3	• 0066	1.2090	•00394	0917
20.00	2337	•0000	3.803	0147	338.3	•0054	1-0195	•00159	- •040
40.00 40.83	2088	0048	6.256	0174	366.8	•0043	• 9006	•00050	- •0139
40.03	2081	0049	6.350	0175	367.6	•0043	.8980	•0004B	- •0135
100.00	1775	0076	12.271	-•0186	397.1	•0032	.8183	+00007	0023
200.00	1558	0083	20.571	-•0186	415.7	•0026	• 7809	•00001	- •0004
400.00	1359	0087	34.597	0186	431.3	•0021	•7484	•00000	- •0001
1000-00	1125	0093	68.879	0186	448.2	•0016	•70B0	-00000	•0000
2000 • 00	968	0096	115.835	0187	458.6	-0013	-6798	•00000	•0000
4000.00	828	0100	194.445	0188	461.4	•0011	•6552	•00000	•0000
	. —	R = 0.0	O. PERC	ENT FUEL	= 13.60)• 0/F	6.349		
1.00	3481	0.0364					2 4 4 9 0 9	0.03537	-0-6319
1.05 1.20	3465	•0361 •0352	2.126 1.242	0.0018	46.0 88.5	0.0119 .0118	2.4777	•03482	6249
1.40	3373	.0341	1.052	•0000	119.7	•0116	2.3938	.03330 .03155	6052
1.60	3331	.0332	1.006	•0003	140.9	+0114	2.3513	•03003	5609
1.73	3306	•0326	1.000	•0000	151.8	•0113	2.3254	•02915	5485
2 • 00 4 • 00	3261	•0316 •0260	1.015 1.350	0006	235.7	•0112 •0103	2.2752	•02752 •01991	- •5249
							2.0021	-01//1	_
10.00	2779	•0170	2.409		296.0	•0090	1.5823	•01097	2447
20.00 40.00	2568 2346	+0087 +0000	3.944 6.587	0139	331.1 360.1	•0080 •0068	1.2725	•00579 •00247	- +1390 - +0641
40.83	2340	0002	6.689		360.8	•0068	1.0207	•00240	0625
100.00	2042	T-0093	14.136		.01				
200.00	1815	0083	13.134		391.4 410.0	•0053 •0043	•8369 •7683	•00073	- •0124
400+00	1602	0126	37.727		427.3	•0035	.7287	• 00002	0008
000+00	1347	0135	76.063	0262	445.3	0037	•6d8g		
2000+00	1173	0141	129.237	-0263	456.6	•0027 •0023	•6594	•00000	0000
000+00	1016	0147	219.200	0265	466.2	•0019	•6320	•00000	•0000
		R = 0+9	O. PERCE	NT FUEL	= 12.28	• 0/F :	7.143		
1.00	3526	0.0393				1			-0.3034
1.05	3511	•0390	2.123	0.0015	44.6	0.0127	2.6628	0.04460	-0.7874 7823
1.20	3469	•0383	1.241			•0126	2.6432	•04279	- ·7680
1.40	3422	0374	1.052	•0006	116.1	-0125	2-6185	.04126	7508
1.60	3382 3360	.0367 .0362	1.005		156.7	•0123 :	2.5953	•03994 •03918	7355 7265
2 • 00	3317	.0354	1.016	0005	165.0	.0121	2.0026	773دو.	7087
4.00	3122	.0314	1.356	0027	220.9	-0114	2.3886	•03089	6170
10.00	2881	.0254	2.437	~•0061	287.9	•0105	2.0940	-02200	4769
20.00	2705	.0199	4.032	0094	327.5	•0105	1.8100	•02200 •01550	3584
40.00	2528	•0127 i	6.838	-•0138	351.5	•0089	1.4813	•00946	2345
40.83	2523	•0125	6.947	0140	352.3	•0089	1.4712	•00930	2309
100-00	2279	0001	13.977	0222	383.4	-0076	1.0541	•00335	- •0922
200.00	2072	0095	24.037	0286	403+7	•0065	• 8410 :	+00105	0313
400.00	1857	0149	41.251		421-1	•0055	•7376	•00025	- •0000
	1585	0176	84.153	-•0331	440.3	ا د 004ء	•6784	•00002	- •0009
								•00002	- 40007
000+00	1397		144.295 247.166	-•0333 -•0335	452.5	.0036	.6487	• 00000	- +0001

TABLE III. - Continued. THERMODYNAMIC DERIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(d) Continued. Combustion-chamber pressure, 600 pounds per square inch absolute

Pressure ratio, P / P	Temp- erature, T,	exponent,	Area ratio, E	Area- ratio exponent,	Specific impulse,	Specific- impulse exponent,	Specific heat,	(ð in M)	(ð ln 977 (ð in †)
P _c /P	°K	n _T		³°	(lb)(sec)/lb	٦	col/(g)(^o K)	l	
		P = 1-4	00, PERC	ENT FUEL	= 11.1	9 • O/F	= 7.937		
	Ι						1	0.04709	-0.8301
1.00 1.05	3534	0.0399	2.122	0.0014	43.3	0.0129	2.6053	•04664	8258
1.20	3478	.0389	1.240	•001c	83.3	•0128	2.5874	.04541	8135
1.40	3431	.0381	1.051	• 0006	112.7	•0126	2.5703	•04399	7985
1.60	3392	•0374	1.005	•0002	132.7	•0125 •0124	2.5542	+04277 +04208	7857
1.73 2.00	3370 3327	.0370	1.000	0004	160.1	.0123	2.5243	•04073	7630
4.00	3137	.0327	1.357	-+0024	222.3	•0117	2.4094	•03451	686:
	2002	0377	2 445	- 00h3	279.6	-0108	2+2079	.02666	5732
10.00 20.00	2903 2738	•0277 •0236	2 • 4 4 5	0053	313.3	•0104	2.0216	.02111	481
40.00	2578	.0192	6.910	0103	341.7	•0096	1.8120	.01600	387
40.83	2573	•0190	7.022	0104	342.5	•0095	1.8056	•01585	365
100.00	2371	.0123	14.326	0146	373.2	+0087	1.5117	•01011	266
200.00	2214	•0061	25.124	0186	393.6	•0080	1.2810	•00647	182
400+00	2052	0011	44.210	0235	411.4	•0072	1.0654	-00366	- •111
000+00	1826	0112	93.124	0305	431.8	•0061	.8338	.00132	045
000+00	1040	0177	:162.695	-•0352	442.0	•0053	•7163	•00047	017
000+00	1470	-•0220	282.648	0381	400.0	•0045	.6444	•00013	- •005
		R = 1.	50. PERC	ENT FUEL	= 7.7	4. U/F	= 1.905		
1 00	3374	0.0324	T	Ī .		1	1.6233	0.02714	-0.514
1.00	13315	•0312	1.242	0.0013	73.5	0.0107	1.5942	.02553	493
1.05	3358	•0321	2.125	•0017	38.2	+0109	1.6157	-02671	- • 508
1.40	3267	•0302	1.052	•0007	99.4	•0106 •0104	1.5682	.02418 .02304	474
1.60	3226	•0293 •0288	1.006	•0003 •0000	126.1	•0103	1.5306	-02237	448
2.00	3158	.0278	1.015	0005	141.3	.0104	1.5034	.02115	- • 430
4.70	2953	•0230	1.351	~•0032	195.9	•0094	1.3606	.01566	343
10.00	2692	.0158	2.415	0073	246.1	•0083	1.1474	•00942	229
20.00	2496	•0097	3.967	0110	275.3	•0074	.9816 .8274	.00569 .00298	151
40.00 40.83	2297	•0032	6.768	0151	299.5 300.2	•0065 •0065	.8232	•00292	086
40.03	2271	•0050	0.,00	10112	1				
100.00	2026	0048	13.428	0202	326.0	•0053	. 6582	+00095 +00031	032
200 • 00 400 • 00	1818	0091 0115	22.891 39.039	0229	342.6	•0044 •0036	•5432	•0000B	003
400 • 00	1010	•0117	3,403,	102.13					
000+00	1366	0130	79.054	0249	372.3	•0028	.5048 .4834	•00001	000
000.00	1195	0137	134.733	0251	382.1	+0024 +0020	.4636	•00000	•000
000-00	1.03.	·	L		1	1			
	·	R = 2•	00. PERC	TT. FOEL	- 5.9 	2, 0/1		F	T
1.00	3158	0.0243			34.9	0.0086	1.1081	0.01418	-0.296
1.05	3141	.0240	1.245	0.0020	67.1	•0085	1.0794	. 01296	277
1.40	3046	.0419	1.054	•0009	90.8	• 0083	1.0543	•01197	260
1.60	3002	•0209	1.006	•0003	106.9	•0081	1.0320	+01114	246
1.74	2975	.0203 .0192	1.000	-0000 0006	115.5	+0080 +0078	1.0182 .9940	•01064 •00980	223
2 • 00 4 • 00	2929 2706	.0137	1.341	0037	176.4	•0069	.8720	.00619	154
					232	0054	7144	00275	- •079
10.00 20.00	2413	•0061 •0008	2.365	0083	223.5	•0056 •0047	•6182	.00278 .00125	- •040
40.00	1965	0032	6.321	0140	270.5	•0038	.5459	•00046	- •017
40.83	1959	0033	6.416	0141	271.1	•0038	•5441	•00045	016
100.00	1678	0062	12.437	0156	293.1	+0029	.4875	•00009	- •003
200.00	1475	0072	20.879	0160	307.00	•0023	•4613	•00002	- +001
400 • 00	1289	0076	35.155	0160	318.7	•0019	-4417	•00000	- •000
000 • 00	1070	0081	70.143	0160	331.3	.0014	.4194	• 00000	•000
000-00	923	0084	118.235	0161	339.2	•0012	•4040	+00000	•000
000-00	792	0087	199.011	0162	345.8	•0010	• 3894	•00000	•000
		H = _3•	DO. PERG	ENT FUEL	= 4.0	3. O/F	= 3.810		7
1.00	2747	0.0120					0+6509	0+00385	-0.097
1.05	2729	.0117	2.152	0.0022	30.6	0.0046	•6451	•00369	- •094
1.20	2679	•0107	1.254	• 0016	58.8	•0044	•6293 •6114	•00328 •00284	085
1.40 1.60	2573	•0096 •0086	1.058	•0009 •0004	79.4	•0042	•5963	•00249	068
1.75	2538	•0079	1.000	•0000	102 • 1	•0039	•5858	+00226	- •062
2.00	2491	•0071	1.011	0005	11200	•003/	-5/20	•00197	056
4 • OC	2237	•0029	1.314	0030	155.0	•0054	•5059	•00085	i
10.00	: 1913	0005	2.253	0050	192+9	•0040	-4460	•00021	- +008
20.00	1682	0017	3.569	0055	. 214.0	.0015	.4185	•00005	- •002
40.00	1470	0022	5.778	0056	231.0	•0011 •0011	•4000 •3995	•00001 •00001	- •000
40.83	1464	0022	7.002	0056	251.4	-0011	i .	- 00001	
100.00		0024	11.130	0055	248.7	+0008	•3811	•00000	
200.00	1053	0025	18 • 422	0055	259.4	•0005 •0005	• 3679 • 3555	•00000	•000
400+00	904	0026	30.593	0054			1	1	
700700									
1000.00		0027 0028	59.908	0054 0054	277.8	•0004 •0003	• 3398 • 3290	•00000	•000

TABLE III. - Concluded. THERMODYNAMIC DEFIVATIVES AT ASSIGNED PRES-SURE RATIOS FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

(d) Concluded. Combustion-chamber pressure, 600 pounds per square inch absolute

TABLE IV. - EQUILIBRIUM COMPOSITION OF PRODUCTS OF REACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN

AND LIQUID OXYGEN

(a) Combustion-chamber pressure, 60 pounds per square inch absolute

				Ŕ =	C.15.	PERCENT I	FUEL = 4	5.65, 0	/F = 1 • 1	90				
Pressure, 1b/sq in. abs Temperature, OK	60.00 1183	50.00 1129	42.86 1035	37•50 1049	32 • 17 1006	15.00 824	14+70 819	6+00 643	3 • 0 0 5 3 2	1+50 439	0+60 340	0+30 280	0 • 0 6 175	0+03 142
н ₂ н ₂ о	0.85000 •15000	0.85000 -15000	0.85000 .15001	0.85000 •15000	0.85000	0.85000		0.85000 •15000	0.85000 -15000		0.85000 -15000		0.85000	0.85000 -15000
		,		R =	0.20.	PERCENT P	UEL = 31	8.65, 0.	/F = 1.5	7				
Pressure, 1b/sq in. abs Temperature, ^O K	60 • 00 1514	50•00 1450	42•86 1398	37.50 1356	32•49 1307	15•00 1079	14•70 1073	6+00 852	3 • 00 709	1.50 568	0+60 4>8	0 • 30 179	0+06 242	0.03
н н ₂ н ₂ 0	0 • 0 0 0 0 1 • 7 9 9 9 9 • 2 0 0 0 0	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0 • 0000 •80000 •20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000
		1	L	R =	0.25,	I PERCENT F	 	i 3•51• 0,	 F = 1.91	 		1	L	l
Pressure, lb/sq in. abs Temperature, ^O K	60•00 1816	50.00 1744	42•86 1686	37•50 1636	32 • 78 1567	15+00 1322	14•70 1316	6+00 1057	3 • 0 0 8 8 7	1.50 741	0•60 581	0+30 482	0•06 310	0•03 256
H H ₂ H ₂ O	0.00017 .74985 .24997	0.00010 .74991 .24998	0.00006 .74994 .24999	C+00004 .74996 .24999	0.00003 .74998 .2>000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000
				R =	0.30.	I PERCENT F	UEL = 25	L 9.57, 0,	F = 2.38	L			l	
Pressure, lb/sq in. abs Temperature, OK	60.00 2089	50•00 2013	42.85 1950	37±50 1896	33•04 1846	15+00 1553	14+70 1546	6•00 1258	3.00 1064	1.50 896	0•60 708	0•30 590	0•06 383	0•03 317
H H ₂ H ₂ O OH	0.00120 .69899 .29975	0 • nno8n • 69932 • 29984 • 00004	0.00056 .69953 .29989 .00002	0.00040 .69966 .29992 .00001	0.00029 .69976 .29995	0.00003 .69998 .30000	0.00103 .69998 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000
	-111.000	100004	•00502	R =		PERCENT F			F = 2.7		-50000	-00000	- 00000	
Pressure, 1b/sq in. abs	60•00 2329	50.00 2253	42.86 2189	37.50 2133	33+32 2085	15 • 00 1772	14.70 1764	6.00	3 • 0 0 1 2 3 9	1.50 1051	0+60	0 • 3 0 70 3	0•06 460	0•03 382
H H ₂ H ₂ O OF	0.00446 .64640 .34873	0.00328 .64735 .34910	0.00248 .64799 .34934	C.CO192 .64844 .34951	0.00151 .64877 .34962	0.00022 .64982 .34995	0.00021 .64983 .34995	0.00001 .64999 .35000	0000cc	0.0J000 .65000 .35000	0.00000 .65000 .35000	0.00000 .6>000 .3>000	0.00000 .65000 .35000	0.00000
OH	•00041	•00027	•00019	•00013	•00010	•00001	•00001	•00000	•00000	•00000	•00000	•00000	•00000	•00000
						PERCENT F			F = 3•17	r		- 20		
Pressure, lb/sq in. abs Temperature, OK	60.00 2531	50.00 2458 0.00867	42.85 2395 0.00702	37.50 2342 0.00577	33.62 2298 0.00488	15.00 1978	14•70 1970 0•00102	6.00 1640 0.00010	3+00 1411 0+00001	1.50 1207	0•60 972 0•00000	0.30 820 0.00000	0.06	0.03 453
H O H ₂ H ₂ O O ₂ OH	0.01092 .00002 .59160 .39584 .00001 .00161	.00001 .59331 .39583 .00000	.00001 .59456 .39752 .00000	•00000 •59552 •39802 •00000 •00068	.00000 .59621 .39837 .00000	0.00106 .00000 .59916 .39970 .00000 .00007	•00000 •59920 •39972 •00000 •00007	*00000 *59992 *39998 *00000	•00000 •29999 •40000 •00000	•0000 •6000 •4000 •0000	•00000 •60000 •40000 •00000	•00000 •60000 •40000 •00000	•00000 •60000 •40000 •00000	•00000 •60000 •40000 •00000
				R =	0.45. F	PERCENT F	UEL = 21	.87. 0/	F = 3.57	1				
Pressure, 1b/sq in. abs Temperature, oK	60+00 2695	50•00 2628	42•85 2070	37•50 2519	33• 3 3 2481	15.00 2167	14•70 2159	6.00 1824	3.00 1581	1.50 1362	0•60 1109	0•30 942	0•06 632	0•03 529
H O H ₂ H ₂ O O ₂ OH	0.02018 -00010 -53544 -43989 -0003 -00435	0.01699 .00007 .93767 .44163 .00002 .00342	0.01451 -00005 -33942 -44320 -00002 -00275	0.01253 -00003 -54083 -44436 -00001 -00224	0.01115 .00003 .54181 .44509 .00001 .00191	0.00340 .00000 .54745 .44877 .00000 .00038	0.00328 -00000 -54754 -44862 -00000 -00036	0.00050 .00000 .54962 .44965 .00000	0.00007 .00000 .54994 .44998 .00000	0.00001 .00000 .54999 .45000 .00000	0.00000 .00000 .55000 .45000 .00000	0.00000 .00000 .55000 .45000 .00000	0.00000 .00000 .55000 .45000 .00000	0.00000 -00000 -55000 -45000 -00000
				R =	0.50. F	ERCENT F	UEL = 20	12, 0/	F = 3.96	В				
Pressure, lb/sq in. abs Temperature, ^O K	60.00 2828	50.00 2765	42+86 2711	37.50 2664	34•19 2632	15•00 2335	14•70 2327	6+00 1996	3 • 0 0 1 7 4 8	1.50 1518	0.60 1247	0•30 1067	0•06 727	0+03
H O H ₂ H ₂ O O ₂ OH	0.03077 .J0036 .47961 .47995 .00015	0.02704 00026 48192 48307 00011 000760	0.02402 .00020 .48502 .48546 .00008 .00642	0.02151 .00015 .48541 .48736 .00006 .00550	0.01985 -00013 -48646 -48626 -00005 -00491	0.00d01 .90002 .49436 .49621 .00091	0.00779 .00001 .49451 .49633 .00001 .00134	0.00174 .00000 .49874 .49934 .00000 .00018	0.00035 .00000 .49974 .49988 .00000	0.00005 .00000 .47776 .47777 .00000	0.00000 -00000 ->0000 ->00000 -00000	•00000 •50000 •50000	0.00000 -00000 -20000 -20000 -00000	0.00000 .00000 .50000 .50000 .00000
				R =	0.60. P	ERCENT F	UEL = 17	.35, U/	F = 4.76	2				
Pressure, lb/sq in. abs Temperature, ^O K	60.00 3015	50.00 2961	42.85 2914	37•50 2874	34.55 2849	15+00 2595	14•70 2506	6•00 2299	3+00 4063	1.50 1829	0•60 1549	0+30 1320	0•06 932	0•03 792
H O H2 H2O O2	0.04998 .00202 .37569 .54591 .00119 .02520	0.04628 -00167 -37696 -00100 -002250	0.04316 .00141 .37807 .22018 .00085 .02031	0.04048 .00121 .37911 .25999 .00073 .01849	0.03884 .00109 .3797> .56225 .00066 .01741	0.02303 .00031 .38583 .28144 .00019 .00819	0.02267 .00030 .38701 .58182 .00019 .00801	0.00943 .00004 .39416 .59399 .00002 .00235	0.00343 .00000 .39776 .59619 .00000 .00059	0.00087 .00000 .39942 .59962 .00000	800000 00000 00000 7444 7444 00000 00000	0.00001 .00000 .40000 .60000 .00000	0.00000 .00000 .40000 .60000 .00000	0.00000 .00000 .40000 .60000 .00000
				R =	0.70, P	ERCENT F	UEL = 15	.25. U/	F = 5.55	6				
Pressure, lb/sq in. abs Temperature, ^O K	50•00 312⊌	50.00 3076	42.86 3037	37.50 3001	34•75 2981	15•00 2761	14•70 2756	6•00 2517	3 • 0 0 2 3 2 0	1.50 2108	0•60 1813	0+30 1596	0•06 1156	0•03 996
H O H ₂ H ₂ O O ₂ OH	0.05035 0.0590 0.26927 0.59195 0.0438 0.04705	0.05790 .00525 .20565 .59964 .00441 .04376	0.05532 -00473 -28855 -60638 -00402 -04101	0.0230d .00429 .20033 .61193 .00370 .03067	0.05130 •00406 •26622 •61505 •00352 •03735	0.03770 .00192 .20014 .64682 .00177 .02366	0.03735 .00186 .28010 .64752 .00174 .02335	0.02275 .00058 .25038 .67406 .00056 .01147	0.01282 .00015 .29381 .68797 .00015	0.00555 .00002 .29700 .69579 .00002	0.00108 -00000 -29936 -69938 -00000 -00018	0.00020 .00000 .29988 .69991 .00000 .00002	0.00000 .00000 .30000 .70000 .00000	0.00000 .00000 .30000 .70000 .00000

TABLE IV. - Continued. EQUILIBRIUM COMPOSITION OF PRODUCTS OF (EACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN AND LIQUID OXYGE)

(a) Concluded. Combustion-chamber pressure, 60 pounds per square inch absolute

				R =	0.80. P	ERCENT F	UEL = 13	.60, 0/	F = 6.34	9			Т	
Pressure, lb/sq in. abs Temperature, ^O K	60.00 3188	50.00 3141	42.86 3103	37•50 3070	34∙85 505∠	15.00 605	14.70 2848	6 • 0 0 2 t 4 5	3 • 0 0 2 4 a /	1+50 2321	0•60 2074	C+30 1868	1328 0•09	0.03
Н	0.06315	0.06063		0.05668	0.05538	0.04433		0.03227		0.01491			0.00003	•00000
0	•01163	-01075	•01003 •2193	.21004	.00910 .21734	.00574 .20957	•00067 •20739	•00292 •20140	.19804	000000	.1570z	•00000	19995	• 40000
H ₂ H ₂ O O ₂ OH	.22260 .62032	.22062 .62957	.63734	64402	64767	. 50043	•66935	.12000	. 75565	•77675	.79540	. 79834	. 79998	.80000
02	.01305	·C1237	•01178	.01127	•01099	•00771	•00763	•00:35	•00226	•00004	00010	•00001	•00000	•00000
óห็	• 06925	•06585	•06301	•06056	•05922	•04422	•04307	•025-01	•01067	•0±00∠	•00273	•00061	•000000	•00000
				R =	0.90, P	ERCENT F	UEL = 12	.28, U	F = 7.14	3				
Pressure, lb/sq in. abs Temperature, ^O K	60.00 3213	50.00 3168	42±85 313±	37.50 ed0c	34.89 3082	15.00 2892	14.70 2ndd	6.00 270±	3+30 2264	1.50 2429	0.60 4246	C+30	0.06 1660	0•03 1466
н	0.05966	0.05741	0.05554	0.05392	0.05306	0.04322	0.04299	0.03322		0.01960	0.01179			0.00008
0	.01787	·C1686	•01502	•01531	•01493	•01084 •15310	•01074 •15200	•00/08 1075/	•00474 •12920	•00204 •1731	•00107 •10/00	•00032 •10202	•00000	• 000000
H2	•17295 •63534	.17043 .64519	.16020 .65350	.00050	.16930 .66434	.70941	.71040	12611	.19114	.02334	.00140	.80266	.09940	. 64449
H ₂ 0 02	• 32642	.02572	-02511	.02407	• 02427	•02046	•9203a	•01.43	•01205	•00s22	•00362	-00120	•00000	•00000
OH OH	-08775	.08430	•08156	•07512	•0778∠	•06287	•06452	•04/50	•03665	•02548	•01445	•00704	•00021	•00002
	L		'·	R =	1.00, F	CRCENT F	UEL = 11	1.19, 0.	/F = 7.93	17		·		
D	60.00	50.00	42.86	37.50	34.91	15.00	14.70	6.00	3.00	1.50	0.60	0 • 30	0.06	0.03
Pressure, 1b/sq in. abs Temperature, ^O K	3217	3173	3136	3104	3000	Z430	2096	2 13	25/9	2452	2207	2164	1859	1710
н	3-05353	0.05143	0.04967	0.04817	0.04736	0.03825 .01555	0.03804	0.02 12	0.02281	0.01710	0.01061	.00198	0.00115	0.00032 .00007
0	.02347 .13620	•02234 •13340	•02141 •13100	.12091	•02019 •12777	11406	+113/2	.09:4L	.04610	.01346	-05644	•04354	.01649	.00612
H ₂ H ₂ 0	.64117	.65113	.65953	.66681	.67071	.71636	•71746	.76:01	•00109	.81010	.55022	•91:25	.96976	.98579
02	.04445	•04394	•04349	+04300	•04286	•03983	•03475	•03577	603423	•02020 •03917	•04243 •04693	•01773 •01886	•00708 •00725	•00213
о й	.10118	•09776	•09490	•09243	•09111	•07595	•07260	•06042	•04942	*03717	*02073	.01300	•00,2,	-00223
				P =	1.50. F	ERCENT I	FULL = 7.	749, 0	/F = 1.90)5		·		
Pressure, lb/sq in. abs Temperature, ^O K	60.00 3116	50.00 3070	42.86 3031	37•50 2999	34•86 2981	15.00 2782	14.70 2777	6:00 2:76	3 • 0 0 24 2 1	1.50 2263	0.60 2040	0 • 30 1656	0.06 1415	0.03 1240
Н	0.02428	0.02275	0.02149	0.02042	0.01985	0.01367	0.01353	0.00.08	0.00476	0.00237	0.00061	0.00013	0.00000	00000
0	•03338	• 03164	•03019	•02895	•02826	•02092	•02075 •03236	•01 -82	•00921	•00241	•00196	•00063 •00114	•00001	•00000
H2	.61197	.04690 .62046	.04501 .62758	•04344 •63371	.04257 .65735	•03260 •6/453	.07542	.71 44	73529	-/6008	.70273	.79298	. 77967	. 79995
H20	.16807	.16939	.17049	.17144	17195	.17/67	.17/51	.16.40	.10756	# L 7 L 3 4	. 1956U	.19792	• TAA88	17778
02 OH	.11322	.10887	•10520	·10204	.10031	•0806C	•08013	·05 /87	.04493	•03104	•01549	•00721	•00041	•00007
	l	1	!	R =	2.00,	PERCENT	 FUEL = 5	927, 0	/F = 5.B7	73	-	-		
Pressure, 1b/sq in. abs Temperature, OK	60+00 2966	50.00 2917	42 • 86 2877	37+50 2841	34•75 2821	15.00 2004	14.70 2599	£ 00 2 165	3 • 9 0 2177	1.50 1976	0+60 1706	0.10	1032 0+0e	0+03 945
н	0.01009	0.00913	0.00835	0.00770	0.00734	0.00395	0.00388	0.00.52		0.00013	0.00001	0.00000	0.00000	0.00000
0	.02669	•02468			•02083	•01295	•01378	•00-50		•00101	•00013	•00002	•00000	•00000
H ₂	.02078	•01933		•C1709	•01651	•01053	•01040	•00 127	•00249	•00088 •65867	+00012 +66479	•00002 •66621	.00000	•66667
H20	•55950	.29473	.57205	.27691	.57960 .29959	.50005	.60869	.63197	.64880 .32970	.327/0	.33245	110001	. 12321	. 2222
02 0H	.29223 .09071	-08579	.03166	.0761G	.07500	.05447	.05396	•03100	.01922	·00×54	•002>0	-00064	•00001	•00000
OR .				L	<u> </u>			<u> </u>	1	<u> </u>	L	l	<u> </u>	L
	•			к ≉	3.00.	PERCENT	FULL = 4	.031.	/F = 3.81	10			·	
Pressure, lb/sq in. abs Temperature, OK	60.00 2655	50.00 2599	42.86 2000	37.50 2009	34.33 2481	15.00 2216	14.70 2209	6.00	19A1 3 • 00	1.50 1400	0.60	0+30 1061	0•06 739	0•03 627
н	0.00150	0.00122	0.00100	0.00084	0.00074	0.00018		0+00 102		0.00000	0.00000	0.00000	0.00000	0.00000
lő	•11009	• 20360	•00745	•00652	•00595	•00206			•00006	•00001	•00000	• 20000	•00000	•00000 •00000
Н2	•00406	• 00348		+00267 +47420	•00244 •47595	•00087 •48901		+00116	•00003 •49904	•00000	• 900000	•50000	•00000	•50000
H20	.46403 .47702	.46010		.48301	.46473	.49311		-49 100	.47742	•49907	• 4 7 7 7 7	•50 00 0	•>0000	•50000
02 ОН	.04329				.03020	.01476		•00 •01	.00144	•00033	•00003	•00000	•00000	•00000
	1	1	<u> </u>	<u> </u>	4.00.	I. PERCENT	FUŁL = 3	.054, 0	/F = 1•74	46	<u></u>	1	1	L
		Τ.	T	T		T				1.50	0.60	0.30	0.06	0.03
Pressure, lb/sq in. abs Temperature, ^O K	60.00 2347	50.00 2202		37.50 2100	33.79	15.00	14.70	9000	1001	110/	954	010	253	464
н	n•00016	0.20011	n.ocon8		0.00004				0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
ő	•00245	• 00185	+00144	•00114	•00094			+000001			•30000	•00000	.00000	•00000 •00000
Н2	•00068	•00052	•00041	•00037 •39361	•90927 •394+1	•00005	•00004 •396~4	•00 300 •35 \$74		-39977	•46000	■ 40000 ■ 40000	•4000C	•40000
H20	• 28900 • 29176				.57573				.59997	•0000L	•00000	•60000	•60000	• 50000
0H 05	•015∀b				•00940		•00247	•00 342	•00007	+00001	•00000	•00000	•00000	•00000
			1	l	2.00.	PERCENT	FULL = 2	.458, U	/f = 5.6	83	+	+	J	1
	T .		1	Т	1	1				1.50	0.60	0+30	0.06	0.03
Pressure, lb/sq in. abs Temperature, OK	60.00 2062				33.40	15 • 00 15 7 s				367	1/0	659	436	365
н	2.00003	0.00001		1.00000	0.00000	0.00000						0.00000	1.00001	
o o	• 10042				•00010	•00001	• 10001			+00000		• 20002	•00000	•00000
H ₂	*00000 atOtt			•90001 •33175	.00002					•00.000		*33333	.2222	
H20	.05433				.00001			1	.0051/	.00507	.0000/		.66667	•66657
									•00000	• 20000	1 .00000	1 . 20020	•00000	•0000n
02 0H	-00-79	□ • □□∃€ 9	• 00285	• 00229	•00187	• 9500 34	• (100 Trains to	1 .0.).2	■ (10°, (3), p=)	. 24 0 2 0	1	* .F.J.Q.J/G	- 33000	-55000.

TABLE IV. - Continued. EQUILIBRIUM COMPOSITION OF PRODUCTS OF REACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN AND LIQUID OXYGEN

(b) Combustion-chamber pressure, 150 pounds per square inch absolute

									.5					_
	150.00	125.00	107.14	93.75	0.15: F	37.50	15.00	14.70	/F = 1.19 7.50	3.75	1.50	0.75	0.15	0+08
Pressure, 1b/sq in. abs Temperature, OK	1183	1129	1085	1049	1008	824	643	639	532	439	340 0+85000	280	0+85000	142
Н ₂ Н ₂ 0	•15000	•15000	•15000	•15000	•15000	•15000	•15000	•15000	·15000	•15000	•15000	•15000	•15000	
		I					FUEL = 36		r	3.75	1.50	0.75	0.15	0+08
Pressure, 1b/sq in. abs Temperature, ^O K	150.00 1514	125.00 1450	107.1÷ 1398	93.75 1354	81.24 1307	37.50 1079	15+00 952	14.70 847	7.50 709	588	458	379	242	198
н Н ₂ Н ₂ 0	0.00001 .79999 .20000	0.00000 .80000 .20000	0.00 00 -80000 -20000		0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0.00000 .80000 .20000	0 • 00000 • 80000 • 20000
				R =	0.25, F	ERCENT F	FUEL = 33	.51. 0.	/F = 1.98	4		·	•	
Pressure, lb/sq in. abs Temperature, ^O K	150.00 1816	125.00 1745	107+14 1686	93•75 1636	81.96 1587	37.50 1322	15.00 1057	14.70 1052	7.50 887	3.75 741	1.50 581	0 • 75 482	0.15 310	0•08 2>8
н н ₂ н ₂ 0	0.00011 .74990 .24998	0.00007 .74994 .24999	0.00004 .74996 .24999	0.00003 .74998 .25000	0.00002 .74998 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0 • 0 0 0 0 0 • 7 5 0 0 0 • 2 5 0 0 0	0.00000 .75000 .25000		0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0+00000 +75000 +25000
				R =	0.30, F	ERCENT F	FUEL = 29	.57, 0	/F = 2.3	31		т		
Pressure, lb/sq in. abs Temperature, oK	150.00 2092	125.00 2015	107.14 1951	93.75 1897	82.58 1846	37•50 1553	15.00 1258	14.70 1251	7.50 1064	3.75 895	1.50 708	0•75 590	0.15 383	0 • 0 8 317
н Н ₂ Н ₂ 0	0.00077 .69935 .29984	0.00051 .69957 .29990	0.00036 .69970 .29993	0.00026 .69978 .29995	0.00018 .69984 .29997	0.00002 .69999 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	•70000 •30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000
off.	•00004	•00002	•00001	•00001	•00001	•00000	•00000	•00000	•00000	•00000	•00000	•00000	•00000	•00000
							TUEL = 26	14.70	7.50	3.75	1.50	0.75	0.15	0.08
Pressure, lb/sq in. abs Temperature, OK	150.00 2339	125.00 2259	107.14 2193	93.75 2137	83.19 2037	37.50 1772	15.00	1444	1239	1051	838	702	460	382
н н ₂ н ₂ о он	0.00296 .64761 .34915 .00028	0.00215 .64826 .34941 .00018	0.00161 .64869 .34957 .00012	0.00124 .64899 .34968 .00009	0.00097 .64921 .34976 .00006	.54988 .34997 .00000	0.00001 .64999 .35000	0.00001 .64999 .35000	0.00000 .65000 .35000	•65000	•6>000 •35000 •00000	•65000 •35000 •00000	0.00000 .65000 .35000	• 65000 • 35000
	L	J		R =	0.40, f	PERCENT F	i FUEL = 23	.95, 0	/F = 3.1	75				
Pressure, lb/sq in. abs Temperature, ^O K	150.00 2553	125+00 2475	107±15 2410	93•75 2353	83.84 2306	3/+50 1978	15.00 1638	14.70 1631	7.50 1410	3.75 1206	1.50 971	0+75 819	0•15 543	0+08 452
Н	0.00758	0.00593	0.00474	0.00386	0.00322	0.00067	0.00006	0.00006	0.00001		0.00000	0.00000	0.00000	0.00000
й ₂ н ₂ 0 он	.59418 .39709 .30115	.59543 .39782 .00082	•59633 •39832 •00061	•59701 •39867 •00046	•59750 •39892 •00036	•59947 •39981 •00004	•59995 •39999 •00000	•59995 •39999 •00000	•00000 •40000	•60000 •40000 •00000	•60000 •40000	•60000 •40000 •00000	•60000 •40000 •00000	• 60000 • 40000
	<u> </u>	L		R ≠	0.45. F	PERCENT F	 	.87. U	/F = 3.5	71				
Pressure, 1b/sq in. abs Temperature, OK	150±00 2733	125.00 2659	107•14 2596	90.75 2542	84.52 2499	37.50 2171	15.00 1819	14.70 1812	7.50 1578	3.75 1359	1.50 1106	0•75 939	0 • 15 631	0•08 528
Н	0.01469	0.01217	0.01025	0.00875	0.00768	0.00220	0.00031	0.00029	0.00004	0.00000	0.00000	0.00000	0.00000	0.00000
0 H ₂	•00006 •53941 •44255	•00004 •54117 •44408	•00007 •24253 •44520	+00002 +54360 +44603	•54436 •44650	•54835 •44920	•54977 •44991	.54978	.54997	•55000 •45000	•55000 •45000	•55000 •45000	•55000 •45000	•55000 •45000
H2O O2 OH	•00002 •00328	•00001 •00253	•00001 •00199	•00001 •00160	•00000 •00134	•00000 •00025	•00000 •00002	•00000 •00002	•00000	•00000	•00000	•00000	•00000	•00000
	L	L		R =	0.50. F	PERCENT !	FUEL = 20	1.12, 0	/F = 3.91	J	1		-	L
Pressure, lb/sq in. abs Temperature, OK	150.00 2881	125.00 2811	107•14 2752	93.75 2701	85.15 2664	37.50 2346	15.00 1994	14.70 1986	7.50 1743	3.75 1512	1.50 1242	0.75 1063	0.15 724	0.08
Н		0.02026	0.01776	0.01573	0.01434	0.00537	0.00108	0.00104	0.00021	0.00003	0.00000	0.0000	0.00000	
0 H ₂	•00021 •48452	•00015 •48646 •48713	•00011 •48804 •48911	+00008 +48934 +49065	.49024 .49167	.49622	•49921	.49925 .49961	.47904	•49998	•>0000	•50000	•>0000	•50000
H ₂ O O ₂ OH	•00009 •00727	•00006	•00005 •00493	•00003	•00C33 •00366	•00000	•00000	•00000	•00000	-00000	•00000	•00000	•00000	
On .		1	100113			1	FUEL = 17			1	1			
Pressure, 1b/sq in. abs Temperature, OK	150.00 3097	125.00 0606	10/-14	93.75 2740	7411 80•04	3/•50 2630	15.00 2308	14.70 2300	7•50 2058	3.75 181>	1.50	0 • 75 1317	0.15 924	0 • 08 786
н		0.03714		0.03193	0.03042		0.00625			0.00051	0.00004	0.00000	0.00000	0.00000
0 H2	•00139 •38033	•00113 •30102 •30002	•00093 •30257	•00078 •30301 •30706	*00070 *38412 *30994	•ncc17 •39033	•00002 •39013 •39503	•00002 •39643 •39643	.00000 .39864 .39890	•00000 •59978	00000 7 ללללנ 8 ללללנ	•00000 •40000	-40000 -60000	• 40000 • 60000
H20 02	• 00082 • 02181	•00067 •01923	•00056 •01/16	•90047 •01949	•00042 •01440	•00011 •00623	•00001 •00157	•00001 •00152	•00000	•00000	.00000	•00000	•00000	
OH	1 -52.101	1	1	L	1		FUEL = 15	'		<u> </u>	1	1		
Pressure, lb/sq in. abs Temperature, OK	150.00	125.00	107.14 3130	9:1/5 309.	50.66 2065	3/=50	15.00	14.70 2544	7.50 2331	3.75	1.50	0.75	0.15 1142	0•0¢
Н	0.15131	0.04040	0.04002	6.04396	0.04273	0.05280	0.01064				0-000054		0.00000	0.00000
O H2	* 67131	• 6 7 U 7 I	• ∠ ∀ U to 3	• 29U43	• Z ~ U 3 ~	* Z 7 O 4 0	€∠∀∠∀8	. Z7300	.27278	.29alb	•544P2	29994 69995	•30000 •70000	•30000 •70000
02	•00375	+90334	•00301	*30274	•00798	•00i17	•con31	•00030	•00007	•00001	•00000	•00000	•00000	•00000
0 H2 H2O	*PC2A1	•01347 •00334	*01211	•0242n	•02603	.01152	•29298 •05104	.00140	•07175	.67/47	10440	•69995	•30000 •70000	•30000 •70000

TABLE IV. - Continued. EQUILIBRIUM COMPOSITION OF PRODUCTS (F REACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN AND LIQUID OXYGEN

(b) Concluded. Combustion-chamber pressure, 150 poinds per square inch absolute

				R =	0.80. F	ERCENT F	ULL = 13	9 • 6 E 1	. 0,	F = 6.34	•9				
Pressure, lb/sq in. abs Temperature, K	150+00 3304	125.00	107.14 3411	93.75 3174	86.97 3154	37.50 2730	15.00 2/04		4.70 2677	7•50 2526	3•75 2338	1.50 2064	0•/5 1846	0 • 1 > 137 >	0.08 1199
H O H ₂ O O O O I	0.05409 .00948 .22134 .63789 .01095	0.05174 .00870 .21952 .64703 .01030	0.04977 .00806 .21800 .65470 .00973	0.04807 .00752 .21669 .66128	•00723 •21597 •66495 •00897	0.03661 .00431 .20828 .70457 .00593	0.02592 .00197 .20161 .74301 .00300	•00 •20 •74	2528 0193 0149 4379	0.01751 .00084 .19855 .76689	0.01028 .00025 .19761 .70433	0.00345 .00002 .19864 .79627 .00003	0.00103 .00000 .19951 .79915	6.00002 .00000 .1999 .7999	0.00000 0.00000 .20000 .80000
οÁ	.06624	•06271	•05974	•05719	•05577	•04031	•02489 UtL = 12	L	2457	•01486 F = 7•14	•00/12	•00159	•00031	•00000	•00000
	110.00	125.00	107.14	93.75	0.90. F	37.50	15.00	_	4.70	7.50	3.75	1.50	0 • 75	0.15	0.08
Pressure, lb/sq in. abs Temperature, K	150.00 3336	3286	3246	3211	3192	2984	2175		2770	2623	2474	2267	2092	1626	1437
н о н2 об ой	0.05120 .01521 .16905 .65494 .02360 .08600	0.04913 .01428 .16643 .66481 .02289 .08247	0.04740 .01351 .16418 .07313 .02226 .07952	0.04592 .01287 .10222 .68031 .02171 .07697	0.04510 .01252 .16113 .68427 .02140 .07558	0.03611 .00882 .14051 .72093 .01759 .06002	0.02704 .00549 .13461 .77575 .01300 .04411	• ()	2685 0543 3430 7677 1289 4377	0.02072 .00347 .12432 .80923 .00936 .03291	0.01493 .00190 .11474 .64001 .00583 .02259	0.00823 .00057 .10473 .87358 .00203 .01086	0.00416 .00013 .1007> .89064 .00049	0.00023 .00000 .09992 .89977 .00000	0.00004 .00000 .09998 .89997 .00000
				R =	1.00+ F	ERCENT F	UEL = 11	1 • 1 > •	• 0	F = 7.93					T
Pressure, lb/sq in. abs Temperature, OK	150.00 3341	125•00 3292	107•14 3252	93.75 3217	87.13 3199	37.50 2994	15.00 2/69	14	4.70 2785	7.50 2644	3.75 2505	1.50 2325	0•75 2188	0.15 1850	7929 0+08
H O H2 H2O O2 OH	0.04560 .02044 .13070 .66145 .04143 .10038	0.04368 .01940 .12776 .67146 .04090 .09681	0+04207 +01854 +12526 +67991 +04043 +09364	0.04069 .01781 .12306 .68721 .04000 .09123	0.03994 .01741 .12186 .69121 .03975 .08982	0.03168 .01317 .10759 .73690 .03662 .07405	0.02349 .00921 .09139 .78551 .03248 .05793	• (2332 (913 5102 8658 3238 5758	0.01792 .00669 .07874 .82121 .02886 .04659	0.01297 .00458 .06586 .85561 .02486 .03611	0.00755 .00245 .04878 .89829 .01910 .02382	0.00442 .00133 .03619 .92757 .01455 .01593	0.00057 .00013 .01164 .97901 .00498 .00366	0.00013 .00003 .00514 .99114 .00226
		r					-UEL = 7:							- 14	
Pressure, lb/sq in. abs Temperature, OK	150.00 3219	125+00 3169	107•14 3127	93.75 3 0 91	86.98 3071	37.50 2653	15.00 2626		4.70 2621	7.50 2455	3.75 2281	2037	0 • 75 1842	0.15 1393	0.08 1220
Н О 0 142 H2O 02 0H	0.01925 .02906 .04359 .b2812 .16847 .11152	0.01792 .02743 .04143 .63646 .16983 .10693	0.01683 .02607 .03961 .04340 .17097 .10306	0.01591 .02491 .03805 .64946 .17195 .09972	0.01540 .02427 .03718 .65281 .17249 .09785	0.01017 -01747 -02759 -68917 -17842 -07718	0.00563 .01103 .01796 .72532 .18445 .05562	•	0554 1090 1776 2608 8458 5515	0.00309 .00698 .01162 .74928 .18866 .04036	0.00139 .00382 .00649 .76922 .19246 .02661	0.00030 .00122 .00212 .76768 .19649 .01220	0.00006 .00035 .00062 .79523 .19846 .00528	0.00000 .00000 .00001 .79981 .19992 .00026	0-00000 -00000 -00000 -79997 -19999 -00004
Pressure, lb/sq in. abs		125•00	107-14	93.75	86.67	37.50	15.00	Γ.	4.70	7.50	3.75	1.50	0.75	0.15	0.08
Temperature, °K H O H2 H2 O O O O O O O H O H O O O	0.00745 .02225 .01742 .57080 .29542 .08666	0.00667 .02043 .01608 .57738 .29769 .08157	0.00604 .01893 .01497 .28263 .29774 .07730	2909 0.00552 .01767 .01403 .56746 .30169 .07363	2886 0.00523 .01694 .01348 .59015 .30270 .07149	0.00263 .01005 .00819 .61669 .31283 .04961	0.00091 .00453 .00379 .64010 .52205 .02664	0.10	2382 0088 0443 0371 4055 2221 2822	2184 0.00029 .00194 .00166 .5278 .52722 .01610	1974 0.00006 .00061 .00054 .66072 .33062 .00744	0.00000 -00007 -00007 -60033 -322/0 -00183	0.00000 .00001 .00001 .66632 .33318 .00046	0.00000 .00000 .00000 .66666 .33333 .00000	935 0.00000 .00000 .00000 .66667 .3333 .00000
Prossume 1h/sq tn. shs	150.00	125.00	107.14	93.75	85.58	37.50	15.00	т -	4.70	7.50	3.75	1.50	0.75	0.15	0.08
Pressure, lb/sq in. abs Temperature, °K H O H ₂ H ₂ O O ₂ OH	2695 0.00096 .00762 .00307 .46923 .48042 .03870	2634 0.00077 .00641 .00260 .47297 .48284 .03441	2582	2537 0.00051 .00475 .00195 .97837 .48632 .02809	2507 0.00045 .00429 .00176 .47995 .48734 .02621	0.00010 .00139 .00059 .49117 .49449 .01226	1914 0.00001 .00023 .00010 .49748 .49846 .00372	0 - 14	1907 0001 0022 0010 9756 9851 0360	0.00000 .00004 .00002 .49927 .49956 .00112	*00000 *00000 *49984 *49990 *00025	0.00000 .00000 .00000 .00000 .49999 .49999	0.0000 .0000 .0000 .0000 .5000 .5000	736 0.00000 .00000 .00000 .>0000 .>0000 .00000	0.00000 00000 00000 00000 20000 50000 00000
Pressure, 1b/sq in. abs	150.00	125.00	107-14	93.75	84.31	37.50	15.00	Γ.	4.70	7.50	3.10	1.50	0.75	0.15	80•0
Temperature, °K H O H ₂ H ₂ O O O O O H	2363		0.00004 .00097 .00027 .39369 .39357 .00926	.00076 .00022 .39464 .59628 .00787	.00062 .00018 .39551 .59676 .00688	•00010 •00003 •39872 •39911 •00204	0.00000 .00001 .00001 .0000 .3990 .5996 .00033	0 - 1	0000 0000 9901 9907 9907	.00006	.00000 .00000 .40000 .00000	0.0000 .00000 .00000 .40000	0-00000 -00000 -00000 -00000 -40000 -65000	0.00000 00000 00000 00000 +0000 00000	0.00000 00000 00000 00000 40000 60000 00000
Programs 1h/sq 1n nhs	150.00	125.00	107.14	93.75	83.45	17.50	15.00		4.70	7.50	3.75	1.00	0.75	0.15	0 • 0 d
Pressure, 1b/sq in. abs Temperature, OK	2066 0.00001 .00028	1998 0-00000 -00018	0.00000	0.00000	1850	15/8	0.00000	0 • 11	1250	0.00000	0 • 0000 APT		650	428	0.0000n .0000n
0 H2 H20 02 OH	•00028 •00006 •33094 •66482 •00389	.00016 .00004 .33154 .66529 .00295	•00013 •00003 •33194 •6561 •00230	.00007 .00002 .33222 .66583 .00183	.00007 .00001 .33243 .66599 .00149		•00000	• H	0000		•00000 •3333 •00607	.00000 .33333 .00607	•00000 •35333 •66667 •00000	.00000 .3333 .56667 .00000	•0000n •3333 •66667 •00000

TABLE IV. - Continued. EQUILIBRIUM COMPOSITION OF PRODUCTS OF REACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN AND LIQUID OXYGEN

(c) Combustion-chamber pressure, 300 pounds per square inch absolute

				R =	0.15,	PERCENT F	UEL = 45	5.65, 0,	/F = 1•19	90				
Pressure, lb/sq in. abs Temperature, ^O K	300.00 1183	250.00 1129	214.29 1085	187.50 1049	160+84 1008	75+00 824	30+00 643	15•00 532	14•70 529	7 • 50 439	3+00 340	1+50 280	0+30 175	0+15 142
H ₂ H ₂ O	0.85000 •15000	0.85000 •15000	0.85000 •15000	0.85000 •15000	0.85000 .15000	0.85000 •15000	0.85000 •15000	0.85000	0.85000 •15000	0.85000 -15000	0.85000 .15000	0.85000 •15000	0.85000 •15000	0.85000 •15000
				R =	0.20,	PERCENT F	UEL = 31	8.65. 0	/F = 1.58	37				
Pressure, 1b/sq in. abs Temperature, K	300.00 1514	250.00 1450	214•29 1398	187.50 1354	162•47 1307	75+00 1079	30+00 852	15+00 709	14•70 705	7.50 588	3+00 458	1.50 379	0+30 242	0+15 198
н ₂ н ₂ 0	0.80000 .20000	0.80000 .20000	0.80000 .20000	•20000	0.80000 .20000	0.80000 -20000	0.80000 •20000	0.80000 •20000	•20000	0.80000 -20000	0.80000 •20000	0 • 8 0 0 0 0 • 2 0 0 0 0	0 • 8 0 0 0 0 • 2 0 0 0 0	0 - 80000 - 20000
	1					PERCENT F	1		T			1		
Pressure, 1b/sq in. abs Temperature, OK	300.00 1817	250.00 1745	214.27	167.50 1636	163.91 1587	7>•00 1322	30+00 1n57	15•00 887	14•70 862	7.50 741	3+00	1•50 482	0•30 310	0+15 2>6
H H ₂ H ₂ O	0.00008 .74993 .24999	0.00005 .74996 .24999	0.00003 .74997 .25000	0.00002 .74998 .25000	0.00001 .74999 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0 • 00000 • 75000 • 25000	0.00000 -75000 -25000
				R =	0.30,	PERCENT F	UEL = 29	9.57. U	/F = 2+36	31	•			
Pressure, lb/sq in. abs Temperature, ^O K	300+00 2093	250+00 2016	214•29 1952	187•50 1897	165.12 1846	75•00 1553	30+00 1257	15+00 1064	14•70 1059	7.50 895	3•00 707	1•50 590	0 • 30 383	0+15 317
н Н ₂ Н ₂ О ОН	0.00055 .69954 .29988 .00003	0.00037 .69969 .29993 .00002	0.00025 .69979 .29995 .00001	0.00018 .69985 .29997 .00001	0.00013 .69989 .29998 .00000	0.00001 .69999 .30000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000	0.00000 .70000 .30000 .00000
		l		R =	0.35.	PERCENT F	UEL = 26	5.47. 0,	F = 2+7	78	l	<u> </u>		
Pressure, lb/sq in. abs Temperature, OK	300 • 00 2344	250•00 2263	214.29 2196	187.50 2139	166.26 2088	75.00 1771	30.00 1451	15.00 1238	14.70 1232	7.50 1051	3 • 00 8 3 8	1.50 702	0+30 460	0•15 3#2
н н ₂ н ₂ 0	0.00214 .64827 .34939 .00020	0.00155 .64875 .34957	0.00116 .64906 .34969	•64928 •34977	0.00069 .64944 .34983	■64992 ■34998	0.00001 .65000 .35000	0.00000 .65000 .32000	0.00000 .65000 .35000	0.00000 .65000 .35000	0.00000 .65000 .35000	0.00000 .65000 .35000	0.00000 .65000 .35000	0.00000 .65000 .35000
OĤ	•00020	-00013	•00009	•00006 R =	L	-00000	l		/F = 3.17	L	100000	10000	100000	
Pressure, lb/sq in. abs Temperature, OK	300 • D0 2565	250•00 2484	214+29 2417	187.50 2359	167.44	75 • 00 1978	30.00 1637	15.00 1409	14.70 1403	7.50 1205	3+00 970	1•50 819	0+30 542	0•15 452
Н	0.00565	0.00437	0.00347	0+00281	0.00233	0.00048	0.00004	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
П О Н ₂ Н ₂ О ОН	•00001 •59566 •39782 •00086	•00000 •59662 •39839 •00061	•00000 •59731 •39677 •00045	•00000 •59782 •39903 •00034	.00000 .59819 .39922 .00026	•00000 •59962 •39987 •00003	*00000 *59997 *39999 *00000	•00000 •60000 •40000	•00000 •60000 •40000	•00000 •60000 •40000	•00000 •60000 •40000	•00000 •60000 •40000	• 00000 • 60000 • 40000	•00000 •60000 •40000
он				R =		PERCENT F			F = 3.57	L	- 00000	00000		
Pressure, lb/sq in. abs Temperature, OK	300 • 00 2755	250•00 2677	214•29 2611	187.50 2555	168.67 2510	75 • 00 2173	30*00 1518	15+00 15/6	14.70 1569	7.50	3.00 1105	1.50 938	0 • 30 6 30	0+15 547
н о	0.01130	•00002	0.00773	•00001	0.00570 .00001	0.00157 .00000 .54882	0.00021 .00000 .54984	0.00003 .00000 .54996	0.00003 .00000 .54998	0.00000 .00000 .55000	0.00000 .00000 .55000	0.00000 .00000 .55000	0.00000 .00000 .55000	0.00000 .00000 .55000
H ₂ H ₂ O O ₂ OH	.54185 .44423 .00001	.54328 .44547 .00001 .00196	.54436 .44636 .00000 .00153	.54521 .44702 .00000 .00122	.44747 •00000 •00101	.44943 .00000 .00018	•44994 •00000 •00001	•44999 •00000	.44999 •00000	•45000 •00000 •00000	•45000 •00000 •00000	•45000 •00000 •00000	•45000 •00000	•45000 •00000 •00000
		l			0.50,	PERCENT F	UEL = 20	0.12, 0,	/F = 3.96	8				
Pressure, lb/sq in. abs Temperature, OK	300+00 2915	250.00 2841	214•29 2778	187.50 2724	169.85 2684	75 • 00 2352	30.00 1992	15+00 1740	14.70 1732	7.50 1509	3•00 1240	1.50 1060	0•30 722	0+15 607
Н	0.01858 -00014	0.01592 .00010	0.01383 -00007	0.01214	0.01097 -00004	0.00391	0.00076	0.00015	•00000	0.00002 .00000 .49999	0.00000	•00000	0.00000 .00000 .>0000	0.00000
H ₂ H ₂ O O ₂ OH	.48771 .48758 •00006 •00595	.48936 .48980 .00004 .00479	.49069 .49145 .00003 .00393	.49177 .49273 .00002 .00328	.49253 .49359 .00002 .00285	.49725 .49815 .00000 .00070	.49945 .49971 .00000	.49989 .49995 .00000	.49990 .49995 .00000	.49999 •30000 •00000	•50000 •50000 •00000	•50000 •50000 •00000	•50000 •00000	•50000 •50000 •00000
OH	L	*00412				PERCENT F								
Pressure, 1b/sq in. abs Temperature, OK	300.00 3155	250.00 3089	214+29 3033	187.50	171.73	75 • 00 2652	30.00	15+00 20>4	14.70	7.50 7.50	3•00 1512	1.50 1311	0•30 919	0•15 782
H O	0•03386 •00100	0.03080 0.8009	C+02826 +00065	0.02611		0.01303	0.00450	0.00145	0.00140	0.00034	•00000	0.00000	0.00000	• 00000
Н2 Н2О 02	.38327 .56191 .00059	.35467 .55662 .00047	•38364 •37036 •00039	.38630 .5/341 .00032	.38737 .57531 .00028	•39252 •58937 •00006	•39/20 •59/14 •00001	.39906 .59924 .00000	• 59927 • 00000	.39977 .59985 .00000	.39998 .39999	•40000 •60000 •00000	•40000 •60000 •00000	•40000 •60000 •00000
OH	•01907	•01664	•01479	•01313		•00492	•00114	•00025	•00023	•00004	•00000	•00000	•00000	•00000
Pressure, lb/sq in. abs Temperature, ^O K	100n	250•00 3298	214.29	R = 19/•50 3010	172.98	75.00 75.00 2865	#UEC = 15 #0•00 #2569	15.00 25.25	7F = 5.55 14.70 2328	7•50 2090	3 • 00 1 / 85	1.50	0•30 ccii	0.15 975
H O		0.04165	0.0394U	0.01745		0+02440 +00087				0.00230	0 • 0003B		0.00000	0.00000
Н ₂ Н ₂ О Оэ	•39267 •01679 •01298	.29226 .02399 .00362	.29 2 03 .02987 .00235	.27155 .03465 .00.215	.2917e .03779 .00196	.29210 .00477 .00081	•29453 •68344 •00018	.29692 .69429	.29699 .69443	.29874 .69830 .00000	• 24414 • 64414	.29996 .69997 .00000	•30000 •70000 •00000	•30000 •70000 •0000n
оЯ	•€397∂	• 23644	•03368	•03132	•02997	•01/05	•00656	•00250	•00244	•00065	•00006	•00001	•00000	•00000

TABLE IV. - Continued. EQUILIBRIUM COMPOSITION OF PRODUCTS OF REACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN AND LIQUID OXYGEN

(c) Concluded. Combustion-chamber pressure, 300 pounts per square inch absolute

	_			R = (.80. P	ERCENT F	JEL = 13	.60: 0/	F = 6.34	9				
resourc, ro/ Nd r acc	300.00	250.00	214-29	187.50	173.68	75.00 2995	30.00 2744	15.00 2520	14.70 2544	7.50	00 • د د د ن ک	1 • 50 1 • 50	0+30 1360	0.15
		0.04529		0.04185	0.04094	0.03116	0.02091	0.01370	0.01349			0.00064		0.00000
	00793	.00722	.00665	.00617	•00590	•00334	•00139	.00053	.19054	•00013	.00001 .1990b	•00000	•00000 •20000	•00000 •20000
2 1	•22002	.66098	.21667	.67492	.21463 .67828	•20/16 •71684	.75296	11429	.77482	.76872	.79759	. 79948	•B0000	.80000
	.65200	.00876	0082	•00776	.00750	•00470	•00215	•00086	•00083	•00022	•00001	•00000	•00000 •00000	•00000 •00000
	.06318	.05956	د 6565	•05393	•05245	.03681	•02124	·01234	•01180	•00>27		•00017	•00000	
				R = 1	90, P	ERCENT F	UEL = 12					1.50	0.30	0 • + 5
ressure, 1b/sq in. abs emperature, ^O K	300.00	250.00 3377	214.29 3334	187.50 3296	173.98 3276	75 • 00 3054	30.90 2029	15.00 2:66	14.70 2661	7.50 2503	3.00 2276	2044	1000	1416
				0.04015	0.03939		0.02278	0.01705	0.01689	0.01187	0.00605	0.00278	0.00013	·00000
C	.01323	.16281	.01167 .16051	.01107 .15850	•01075 •15757	14454	13029	12620	.12021	-11147	.10276	•100∠7°	•04442	•03335
20	.16552	.68077	68904	.69619	.70010	. 14437	.79034	.02.11	02302	.05169	.00119	• 69312 • 00022	•00000	• 00000
2 20 fi	.02140	-02068	•02006 •07720	.01950 .07458	•01919 •07313	•01540 •05721	•01090 •04098	•00745 •02566	.00735 .02934	•00425 •01940	.00847	000295	•00005	•0000
A	.08385	•08023	•07720		ا ــــــــــــــــــــــــــــــــــــ	ERCENT F								
		252.00	214.29	187.50	174.06	75.00	30.00	15.00	14.70	7.50	3•00	1.50	0 • 30	0.1
ressure, lb/sq in. abs emperature, OK	300.00 3437	250•00 3384	3341	3304	3284	3065	2047	5935	2687	2542	2349	2203	1839	1661
	0.03987	0.03809	0.03661		0.03464	0.02707 .01143	0.01963 .00782	0.01:65	0.01451	0.01030	0.00569 .00186	6160000 490000	0.00034 -00007	•0000
)	.01816 .12585	.01719 .12283	.01639 .12025	.01571 .11800	•01534 •11674	.10213	-08562	.07.83	.07244	.05991	.04302	.03088	-00872	• 00 35
120 220	.67806	.68505	.69648	.70371	.70783	15328	.80148	.83.67	769ده.	.02232	.91144 .01667	•91400 •01212	.98446 .00373	•665
150	.03906	.03851	03802	.03758 .08959	•03733 •08813	•03412 •07197	•02993 •05001	•02 30 •04 01	.02618 .04369	.02232	.02132	.01374	•00≥10	•0008
)H	•09900	•09532	•09224			PERCENT F			/F = 1.90					
ressure, lb/mq in. abs	300.00	250.00	214.29	187.50	173.72	75 • 00	30.00	15-00	14.70	7.50	3 • CO	1.50	0.30 1379	0.1
emperature, ok	3297	3243	3198	9 1 5 و	3137	2904	2661	∠ +78	2472	0.00090	0.00017	0.00003		0.0000
	0.01582	0.01466	0.01370 .02300	0.01289 .02192	0.01243	0.00794 .01498	0.00416 .00911	0.00 216 -00 254	•00544	•00287	•00083	•00022	•00000	•0000
	.03926	.03716	•03540	.03388	•03302	•02388	•01492	+00124	•00909	.774/2	.79041	•00040 •7964∠		•0000 •7999
12 120	.64080	.64897	.65560	.60166	.66499	.70013	.73457	.75581	.169/1	19333	.19708	.19876		1999
120 D2 DH	.16901 .10929	.17040 .10454	.17157 .10054	.17257 .09708	.17313 .09512	•17919 •07387	-05190	.0.,66	.03623	16650.	.01006	•00415	+00019	•0000
ОН	•10929	10434				PERCENT F	i	927. 0	/F = 5.B	73	L			
22 (1- 22)	300+00	250.00	214.29	187.50	173.03	75+00	30.00	15.00	14.70	7.50	3.00	1.50	0.30	0+1 92
Pressure, lb/sq in. abs Temperature, K	3103	3046	2998	2957	2932	2679	2402	5199		1970	1686	0.00000	<u> </u>	
н	0+00578	0.00513	0.00461	0.00419 .01491	0.00395		0.00060	0.00)18 -00 140	.00136	0+00004 +00042	•00005	•00001	•00000	•0000
0	.01907	.01375	.01273	•01187	.01136	.00664	•00289	• OC 120	•00116		.66562	•00001 •66642		•0000 •6666
H ₂ H ₂ O	.57933	.58564	.59085	.59527	.59788	.62279	.64414	.65524		.66171	. 33283	.33321		. 2 2 2 2
0 ₂ OH	.29800		.30244 .07333	•30414 •06963	•30515 •06742	+04564	.02536	•01377	.01348		•00145	+00036		•0000
OH	•08282	107103	1 •0.333	L	1	PERCENT	1	ــــ	/F = 3.8	10	I	1	— —	
				- * -	3.00,	PERCERT								
	1	1 75 0 00	216.20	187-50	170.82	75 • 00	30.00	1:.00	14.70	7.50	3.00	1.50		
Pressure, lb/sq in. abs Temperature, ^O K	300 • 00 2723		214.29 2604	187.50 2556	170+82 2523		30+00 1914	15 • 00 1 58 4	1678	1472	1222	1050	735	64
Temperature, ^O K	2723	2658	2604	2556	0.00030	0.00006	0.00001	0+0(000	0.00000	0+00000	0.00000	0.00000	735	0.0000
Temperature, OK H O	0.00067 0.00605	0.00053 .00505	2604 0.00042 000428	0.00035 .00368	0.00030	0.00006	0.00001 .00016 .00007	0.0(000	0.00000 .00002 .00001	0.00000 -00000 -00000	0.00000 .00000 .00000	0.00000 0.00000 0.00000	735 0.00000 .00000 .00000	0.0000
Temperature, ^O K H O	2723	0.00053 .00505 .00205 .47630	2604 0.00042 .00428 .00175 .47900	0.00035 .00368 .00151 .48120	0.00030 .00330 .00136 .48265	0.00006 -00102 -00043 -49253	0.00001 .00016 .0007 .49792	0.00000 00003 00001	0.00000 .00002 .00001	0.00000 00000 00000 00000	0.00000 .00000 .00000 .49995	0.00000 .00000 .00000	735 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 .0000 .0000
Temperature, ^O K H 0 H ₂ H ₂ 0 O ₂	2723 0.00067 .00605 .00244 .47287 .48280	0.00053 .00505 .00205 .47630 .48501	2604 0.00042 .00428 .00175 .47900	0.00035 .00368 .00151 .48120	0.00030 .00330 .00136 .48265	0.00006 .00102 .00043 .49253 .49537	0.00001 .00016 .0007 .49792	0+0(000 +0(003 +0(001 +4:940 +4:964	0.00000 .0002 .0001 .49942	0.00000 00000 00000 00000 49987	0.00000 .00000 .00000 .44444	0.00000 .00000 .00000 .50000	735 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 .0000 .0000 .5000
Temperature, ^O K H 0 H ₂ H ₂ 0 O ₂	2723 9.00067 .00605 .00244 .47287	0.00053 .00505 .00205 .47630 .48501	2604 0.00042 .00428 .00175 .47900	0.00035 .00368 .00151 .48120 .48816 .02510	0.00030 .00330 .00136 .48265 .48905	0+00006 +00102 +00043 +49253 +49537 +01058	0.00001 .00016 .00007 .49792 .49673 .00312	0.00000 00000 00001 00001 045964 00093	0.00000 .00002 .00001 .49942 .49965	0.00000 .00000 .00000 .49987 .49992 .00021	0.00000 .00000 .00000 .49995	0.00000 .00000 .00000 .50000	735 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 .0000 .0000 .5000
Temperature, ^{OK} H 0 H ₂ H ₂ 0 O2 OH	2723 0.00067 .00605 .00244 .47287 .48280 .03516	2658 0.00053 .00505 .00205 .47630 .48501 .03107	2604 0.00042 .00428 .00175 .47900 .48675 .02779	2556 0.00035 .00368 .00151 .48120 .48816 .02510	0.00030 .00330 .00136 .48265 .48909 .02330	0.00006 .00102 .00043 .49253 .49537 .01058	1914 0.00001 .00016 .00007 .49772 .49873 .00312 FUEL = 3	0.00 000 00 003 00 001 045 964 00 093	1678 0.00000 .00002 .00001 .49942 .00089	0.00000 .00000 .00000 .49957 .49992 .00021	0.00000 .00000 .00000 .4777 .4777 .00002	0.00000 .00000 .00000 .50000 .50000	735 0.00000 0.00000 0.00000 0.20000 0.50000 0.50000	0.000 0.000 0.000 0.000 0.000 0.000
Temperature, ^O K H 0 H ₂ H ₂ 0 O ₂	2723 0.00067 .00605 .00244 .47287 .48280	2658 0.00053 .00505 .00505 .47630 .48501 .03107	2604 0.00042 .00428 .00175 .47900 .48675 .02779	2556 0.00035 .00368 .00151 .48120 .48816 .02510	0.00030 .00330 .00136 .48265 .48905	0.00006 -00102 -00043 -49537 -01058 PERCENT	1914 0.00001 .00016 .00007 .49772 .49873 .00312 FUEL = 3	0.00 0000 00 0001 00 001 045 940 045 964 00 093 054 00 11 000	1678 0.00000 .00002 .00001 .49942 .4995 .00089 00089 00089 14-70 134-2	1472 0.00000 00000 00000 49987 .49992 00021 46	0.00000 .00000 .00000 .4777 .4777 .00002	1055 0.00000 00000 00000 050000 050000 00000	735 0.00000 0.00000 0.00000 0.00000 0.50000 0.50000	0.000 0.000 0.000 0.000 0.000 0.000
Temperature, OK H 0 H ₂ 0 H ₂ 0 0 0 O 0 Pressure, lb/sq in. abs Temperature, OK	2723 0.00067 0.00605 0.0244 47287 48280 0.3516	2658 0.00053 .00505 .00205 .47630 .48501 .03107 250.00 2303	2604 0.00042 .00428 .00175 .47900 .48675 .02779 214-29 _2244	2556 0.00035 .00368 .00151 .48120 .46816 .02510 R = 187.50 .2194	2523 0.00030 .00330 .00136 .48265 .48905 .02330 4.000	2232 0-00006 -00102 -00043 -49253 -01058 PERCENT 75-00 1859	1914 0.00001 .00016 .00007 .49772 .49873 .00312 FUEL = 3 30.00 100000	0.00 000 00 000 00 001 00 001 00 001 00 001 00 000 00 0	1678 0.00000 .00002 .00001 .49942 .49965 .00089 0/F = 1.7	1472 0-00000 -00000 -00000 -49972 -00021 46	0.00000 0.00000 0.0000 0.0000 0.4949 0.00002	1055 0.00000 0.00000 0.00000 0.50000 0.50000 0.00000	735 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 0.0000 0.0000 0.0000 0.0000
Temperature, OK H 0 0 H ₂ H ₂ 0 02 0H Pressure, lb/sq in. abs	2723 0-00067 -00605 -00244 -47287 -48280 -03516 300-00 2372	2658 0.00053 .00505 .00205 .47630 .48501 .03107 250.00 2303 0.00004 .00094	2604 0.00042 .00428 .00175 .47900 .48675 .02779 214-29 .2244	2556 0.00035 .00368 .00151 .48120 .48816 .02510 R = 187.50 .2194 0.00002 .00056	2523 0.00030 .00330 .00136 .48265 .4890 .02330 4.00 168.42 2153 0.00001 .00045	2232 0-00066 -00102 -00043 -49253 -49257 -01058 PERCENT 75-00 1859	1914 0.00001 .00016 .00007 .49792 .49873 .00312 FUEL = 3 30.00 1535 0.00000 .00000	0.00 000 00000 00000 00000 00000 00000 0000 0000	1678 0.00000 .00002 .00001 .49942 .00089 0.00000 .00000 .00000 .00000 .00000 .00000 .00000	1472 0-00000 -00000 -00000 -49987 -4992 -00021 46 7-50 1162 0-00000 -000000 -000000	3.00 3.00 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	0.00000 -00000 -00000 -50000 -50000 -50000 -00000 -00000 -00000	735 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
Temperature, OK H 0 H 2 H 2 O 2 OH Pressure, lb/sq in. abs Temperature, OK H 0	2723 0.00067 .00605 .00244 .47287 .48280 .03516 300.00 2372 0.00066 .00126 .00035	2658 0.00053 0.00505 0.00505 0.7650 0.48501 0.03107 250.00 2303 0.00004 0.0094 0.0026	2604 0.00042 .00428 .00175 .47900 .48675 .02779 214-29 .2244	2556 0.00035 .00368 .00151 .48120 .48816 .02510 R = 187.50 .2194 0.00002 .00056 .00016	2523 0.00030 .00330 .00136 .48265 .48900 .02330 4.00, 168.44 2153 0.00001 .0004 .00013	2232 0.0006 0.0102 0.0043 49253 49257 0.1058 PERCENT 75.00 1859 0.00007 0.0002 39893	1914 0.00001 .00016 .00007 .49772 .49873 .00312 FUEL = 3 0.00000 .00000 .39983	0.0(000 0.0(000 0.0(003 0.0(001 0.45940 0.45964 0.0(093 0.54 0.000 0.345	1678 0.00000 00002 00001 49942 49965 00089 0/F = 1.7 0 14470 1343 0 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.000000 0.000000 0.000000 0.0000000 0.000000 0.000000 0.000000 0.00000000	1472 0-80000 -00000 -00000 -49992 -0001 46 7-50 1162 0-00000 -00000 -40000	3-00 3-00	0.00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000	735 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 .0000 .0000 .5000 .5000 .5000 .0000 .0000
Temperature, OK H 0 H ₂ 0 H ₂ 0 O2 OH Pressure, lb/sq in. abs Temperature, OK H 0 H 10 H 10 H 10 H 10 H 10 H 10 H 10	2723 0.00067 .00605 .00244 .47287 .48280 .03516 300.000 2372 0.00006 .00126 .00035 .39225 .59436	2658 0.00053 .00505 .00205 .47630 .48501 .03107 250.00 2303 0.00004 .00094 .00094 .00094 .00956 .39372 .39547	2604 0.00042 .00428 .00175 .47900 .48673 .02779 214.22 2444 0.0002 .39486 .39486 .39466	2556 0.00035 .00368 .00151 .48120 .48816 .02510 R = 187.50 2194 0.00002 .00056 .00016 .39562 .39687	2523 0.00033 0.0033 0.00136 4.48265 48905 0.2332 4.00, 168.44 2153 0.0003 0.0003 0.0003 0.0003 0.0003	2232 0.00006 .00102 .0003 .49253 .01058 PERCENT 75.00 .00007 .00007 .00007 .39893 .39926	1914 0.00001 .00016 .00007 .49972 .49873 .00312 FUEL = 3 0.00000 .00000 .00000 .00000 .00000 .9983 .9985	0.00 0000 0000 0000 0000 0000 0000 000	1678 0.00000 0.0002 0.0001 14994 0.00089 //F = 1.7 0.00000 0.000000 0.000000 0.000000 0.000000	1472 0-00000 -00000 0-00000 -4777 -4	3+00 3+00 0-00000 3+777 3+00 3+00 0-00000 0-00000 0-00000 0-00000 0-00000	1055 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	735 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.00000000	0.0000 .0000 .0000 .5000 .5000 .5000 .5000 .5000 .0000 .0000 .6000
Temperature, OK H 0 H 2 H 2 O 2 OH Pressure, lb/sq in. abs Temperature, OK H 0	2723 0.00067 00067 000244 47287 48280 03516 300.00 2372 0.0006 00126 00036 00036 00036	2658 0.00053 .00505 .00205 .47630 .48501 .03107 250.00 2303 0.00004 .00094 .00094 .00094 .00956 .39372 .39547	2604 0.00042 .00428 .00175 .47900 .48673 .02779 214.22 2444 0.0002 .39486 .39486 .39466	2556 0.00035 0.0358 0.0151 0.48120 0.4816 0.2510 R = 187-50 2.194 0.00002 0.0056 0.0016 0.39562 0.39562 0.39562 0.39567	2523 0.00033 0.0136 4.8425 4890 0.2330 4.00, 168.44 2153 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0003 0.0030 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0.0033 0	0.00006 00102 00043 4923 4923 0.0068 PERCENT 75.0005 0.0007 0.00000 0.0007 0.00000 0.0007	1914 0.00001 00016 00007 49792 49673 00000 10000 000000 000000	0+0 (000 000 000 000 000 000 000 000 000	0.00000 .00002 .00001 .4992 .4995 .00089 //F = 1.7 .014.77 .014.77 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000	0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00001 0.000000	3+00 3+00 0-00000 3+777 3+00 3+00 0-00000 0-00000 0-00000 0-00000 0-00000	1.55 0.00000 0.00000 0.50000 0.50000 0.50000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	735 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.00000000	0.0000 .0000 .0000 .5000 .5000 .5000 .5000 .0000 .0000 .4000 .4000 .4000 .4000
Temperature, OK H 0 H 2 H 2 0 O 2 OH Pressure, lb/sq in. abs Temperature, OK	2723 0.00067 0.0605 0.0244 4.7287 .48280 0.03516 300.00 2372 0.0006 0.0128 0.0035 3.9225 5.9436 0.0171	2658 0.00053 .00205 .00205 .47630 .48501 .03107 250.00 .2303 0.00004 .00026 .39372 .39547 .00958	2604 0.00042 0.0428 0.0175 .4790 .48673 0.2779 214-29 2244 0.0002 .3948 .5962 .00793	0.00035 .00358 .00358 .00151 .48120 .48216 .02510 R = 187.50 .2194 0.00002 .00056 .0016 .39562 .9687 .9687	2523 0.00030 .00330 .48265 .48907 .2332 4.00, 168.42 .0003 .0004 .0003 .3962 .5973 .0058	2432 0.00006 00102 00043 4923 4923 4923 75.00 1659 0.000000	1914 0.00001 00016 00007 49792 49673 00312 FUEL = 3 30.00 0.0000 0.0000 0.0000 0.9998 0.9998 0.9998 FUEL = 2	0.00 000 000 000 000 000 000 000 000 00	1678 0.00000 0.0002 0.0001 4.4944 4.4945 0.0008 0.008 0.	1472 0.00000 .00000 .49987 .49987 .49987 .400000 .0000000000000000000000000000	3-00 3-00 0-0000 4-7979 	1055 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
Temperature, OK H 0 H ₂ 0 H ₂ 0 0 0 OH Pressure, lb/sq in. abs Temperature, OK H 0 H ₂ H ₂ 0 H 0 H ₂	2723 0.00067 0.0605 0.0244 4.7287 4.8280 0.03516 300.00 2372 0.0006 0.0126 0.0035 3.9225 5.9436 0.0171	2658 0.00053 .00505 .00205 .47630 .48501 .03107 250.0004 .00094 .00094 .00094 .00958	2604 0.000942 .00428 .00175 .47900 .48673 .02779 214.29 .00071 .00022 .3948 .9062 .00793	0.00035 .00358 .00358 .00151 .488120 .488126 .02510 R = 187.50 2194 0.00002 .00056 .00016 .39562 .95657 .00677	2523 0.00030 .00330 .48265 .48907 .2332 4.00, 168.42 .0003 .0004 .0003 .3962 .5973 .0058	2232 0.00006 00102 00003 49423 001058 PERCENT 75.00007 0.00002 39992 0.00172 PERCENT	1914 0.00001 00016 00007 49792 49873 00312 FUEL = 3 0.00000 0.00000 0.39983 0.00028 FUEL = 4 30.00	0.000000000000000000000000000000000000	1678 0.00000 0.00001 0.00001 0.49942 0.00001 0.49942 0.00000 0.00000 0.000000 0.000000 0.000000	0.00000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0	0.00000 .00000 .00000 .47979 .00002 .722 0.00000 .00000 .00000 .00000 .00000 .00000	1055 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	735 0.00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .000000 .000000 .000000 .000000 .000000	0.00000 ->00000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->00000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->00000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->0000 ->00000 ->00
Temperature, OK H 0 H 0 H 0 H 0 O 0 O O O O O O O O O	2723 0.0067 0.0605 0.0024 47287 48280 0.03516 300.000 2372 0.00006 0.0128 0.0005 39225 0.0171	2658 0.00053 0.00505 0.0205 4.7630 4.48501 0.3107 250.000 2303 0.00004 0.00034 0.00034 0.0005 0.33377 0.0058	2604 0.00042 .00428 .00175 .47790 .48675 .02779 214.29 .00071 .00022 .39486 .9962 .90793	0.00035 .00368 .00151 .48120 .48816 .02510 R = 187.50 .2194 0.00002 .00056 .0016 .39562 .39562 .39567 .00677 R =	29:23 0:00030 0:0030 0:0036 48:265 48:909 0:2330 4:000 168:44 (193) 0:0003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00003 0:00000	2232 0.00006 -00102 -00102 -00103 -49453 -49453 -49453 -60568 PERCENT 75.00 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00007 0.00000000	1914 0-00001 00016 00007 -49772 -49873 -00312 FUEL = 3 0-00000 000000 000000 000000 1000000	0.0(000 0.0(000 0.0(000) 0.0(001) 0.0(001) 0.0(001) 0.0(000) 0.0(0	1678 0.00000 0.00001 0.00001 0.49942 0.00001 0.49942 0.00089 0.00000 0.000000 0.000000 0.000000 0.000000	1472 0.00000 0.00000 4.4792 0.0001 46 0.00000 0.00000 0.00000 0.000000 0.000000	3-00 -000000	1055 0-00000 -00000 -50000 -50000 -50000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000	735 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
Temperature, OK H 0 N2 H20 O2 OH Pressure, lb/sq in. abs Temperature, OK H2 H20 O2 OH Pressure, lb/sq in. abs Temperature, OK H2 H20 O2 OH Pressure, lb/sq in. abs	2723 0.0067 0.0605 0.0724 4.47287 4.8280 0.3516 300.00 2372 0.0006 0.0126 0.0025 5.9436 0.0171	2658 0.00053 0.00053 0.0005 47630 47630 250.000 2303 0.00004 0.00025 0.00004 0.00058 0.00058	2604 0.00042 .00042 .00043 .00175 .47700 .48673 .02779 214.29 .2244 0.0002 .3948 .0079 .0079 .0079 .0079 .0079	2556 0.00035 0.0358 0.0151 4.8120 4.8210 7.2510 R = 187.50 2.194 0.00002 0.0056 0.0016 0.	2923 0.00030 .00330 .00330 .40330 4.00, 168.42 .2132 4.00, 168.42 .00031 .0004 .00031 .9062 .9073 .9098	2232 0-0006 -00102 -00103 -00103 -00105 PERCENT	1914 0.0001 0.0016 0.0016 0.0016 0.0016 0.0017 0.0017 0.0012 0.000000	1:684 0-0(000 -0(001	1678 0.00000 0.00002 0.00001 4.4942 4.49405 0.0005 0.00000 0.000000 0.000000 0.000000 0.000000	1472 0.00000 0.00000 0.00000 0.4y997 0.00000 0.1599 0.000000 0.000000 0.000000 0.000000 0.000000	3+00 3+00 0+0000 0+	1055 0-00000	735 0.00000	0.0000 0.000000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00
Temperature, OK H 0 H 0 H 0 H 0 O 0 O O O O O O O O O	2723 0.0067 .00607 .00607 .00244 .47287 .48280 .03516 300.00 2372 0.00066 .00126 .00126 .00126 .00171	2658 0.00053 0.00053 0.00055 0.00205 0.00205 0.00205 0.00004 0.00026 0.0002	2604 0.00042 .00428 .00175 .47790 .48675 .02779 214.29 .00071 .00022 .39486 .59621 .194	0.00035 .00368 .00151 .48120 .48816 .02510 R = 187.50 .2194 0.00056 .00016 .39562 .39562 .39567 R = 187.50 .39562 .39562 .39562 .39567	2923 0.00030 .00030 .00036 .48405 .48405 .48905 .02330 4.00. 168.4 .0001 .0004 .0001 .3962 .5973 .0058 5.006	0.00000 00102 000102 00043 4923 4953 1959 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.000000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00	1914 0-00001 00016 00007 -49772 -49873 -00312 FUEL = 3 0-00000 000000 000000 000000 19998 -9998 -1900 1900 000000 000000 00000000 000000 000000	0-0 (000 0 (000 0 (000) 0 (001) 0 (001) 0 (001) 0 (001) 0 (000) 0 (1678 0.00000 0.00001 0.49942 0.49940 0.0001 0.49942 0.49940 0.00000 0.000000 0.000000 0.000000 0.000000	1472 0.00000 0.00000 0.49992 0.00021 0.00000	0.00000 3.00 0.0000 4.4999 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000 0	1055 0-000000	0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0.00000 0 0 0 0.00000 0 0 0 0.00000 0 0 0 0.00000 0 0 0 0.00000 0 0 0 0 0.00000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0.00000 -00000 -00000 -00000 -00000 -0000

(d) Combustion-chamber pressure, 600 pounds per square inch absolute

				R =	0.15, F	PERCENT	FUEL = 4	5.65, 0	/F = 1•19	90				
Pressure, 1b/sq in. abs Temperature, OK	600.00	500.00 1129	428.57 1085	375.00 1049	321+68 1008	150.00	60.00	30.00	15.00	14.70	6+00	3•00 280	0•60 175	0+30
Temperature, ^O K H ₂ H ₂ O	0.85000	0.85000	0.85000	0.85000 -15000	0.85000		0+85000		0.85000		0.85000			0.85000
H2O	•13000	•13000	-15000	L	L	L	FUEL = 3!	L	/F = 1.58	Ļ				
Pressure, lb/sq in. abs Temperature, K	600.00 1514	500•00 1450	428.57 1398	375.00 1354	324•94 1307	150+00 1079	60•00 852	30.00 709	15 • 00 588	14.70	6 • 00 458	3+00 379	0•60 242	0.30
H ₂ H ₂ O	0.80000 •20000	9 • 8 n o o o • 2 o o o o	0.80000 .20001	0+80000 +20000	0+80000 +20000	0+80000 +20000		0.80000 •20000		0.80000	0.80000		0+80000 +20000	0 • 80000 • 20000
				R =	0+25+ F	PERCENT	FULL = 3	3.51, 0	/F = 1.98	4				
Pressure, 1b/sq in. abs Temperature, ^O K	600.00 1817	500+00 1745	428.57 1686	375.00 1636	327.81 1587	150+00 1322	60.00 1057	30±00 887	15+00 741	14.70 737	6•00 581	3+00 482	0.60 310	0+30 256
н н ₂ н ₂ о	0+00006 •74995 •24999	0.00003 .74997 .25000	0.000002 .74998 .25000	0.00001 .74999 .25000	0.00001 .74999 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	•75000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000	0.00000 .75000 .25000
				R =	0.30. F	PERCENT	FUEL = 29	9.57. 0	/F = 2.36	31				
Pressure, lb/sq in. abs Temperature, K	60C+00 2094	500•00 2016	428.57 1952	375 • 00 1898	330•21 1847	150.00 1553	60+00 1257	30+00 1064	15+00 895	14.70	6 • 00 707	3•00 590	0•60 585	0.30 317
H H ₂ H ₂ O OH	0.00019 .69967 .29992	0.00026 .69978 .29995 .00001	0.00018 .69985 .29996 .00001	0.00013 .69989 .29998 .00000	0.00009 .69992 .29998	0.00001 .69999 .30000	0.00000 -70000 -30000 -00000	0.00000 .76000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000	0.00000 .70000 .30000
——————————————————————————————————————	•00002	•00001	•00001		L	ļ	FUEL = 28		/F = 2.71	<u> </u>	-00000	- 00000		
Pressure, 1b/sq in. abs Temperature, 0K	600.00 2347	500•00 2266	428•57 2199	375.00 2140	332.36 2089	150:00	60.00 1451	30.00 1236	15.00 1050	14.70 1045	6 • 00 838	3 • 00 702	0+60 460	0.30 382
H H ₂ H ₂ O	0.00154 .64875 .34956	0.00111 .64910 .34969	0.00083 .64933 .34978	0.00063 .64949 .34984	0.00049 .64960 .34988	0-00007 -64994 -34998	•65000 •35000	•65000 •35000	•35000	•65000 •35000	•65000 •35000	0.00000 .65000 .35000	•65000 •35000	0.00000 .65000 .35000
ОН	•00015	• 00009	+00006	•00004	•00003 0•40• F	•00000	•00000 FUEL = 23	•00000	•00000 /F = 3•17	•00000	•00000	•00000	•00000	•00000
Pressure. 1b/sq in, abs	600.00	500.00	428.57	375.00	334.53	150.00	60.00	30.00	15.00	14.70	6.00	3+00	0.60	0.30
Pressure, lb/sq in. abs Temperature, OK	2574	2492	2422	2363	2313	1978	1637	1408	1204	1199	970	818	542	452
Н Н ₂ Н ₂ О ОН	0.00416 .59681 .39839	0.00320 .59753 .39882 .00045	0.00252 .59805 .39910 .00033	0.00203 .59842 .39930 .00024	0.00167 .59870 .39944 .00019	0.00034 .59973 .39991	0.00003 .59998 .39999	0.00000 .60000 .40000	0.00000 .60000 .40000	0.00000 .60000 .40000	0.00000 .60000 .40000	0.00000 .60000 .40000	0.00000 .60000 .40000	• 60000 • 40000 • 00000
1	L			l	L	PERCENT P	UEL = 21	.87, 0,	 /F = 3.57	<u> </u>				l
Pressure, 1b/sq in. abs Temperature, OK	600 • 00 2773	500•00 2692	428•57 2624	375 • 00 2565	336•72 2517	150.00 2174	60.00 1017	30.00 1575	15+00 1357	14.70 1350	6+00 1104	3•00 937	0 • 60	0+30 526
H O H ₂	0 • 0 0 8 5 6 • 0 0 0 0 2 • 5 4 3 8 3	0.00695 .00001 .54496	0.00575 .00001 .54581	0 • 00 4 8 3 • 00 0 0 1 • 5 4 6 4 6	0.00417 .00000 .54694	0.00112 .00000 .54916	0.00015 .00000 .54989	0.00002 .00000 .54998	.00000 .55000	0.00000 .00000 .55000	•00000 •55000	0.00000 00000 055000	•00000 •>5000	0.00000 .00000 .55000
H2O O2 ОН	•44560 •00001 •00198	•44659 •00000 •00149	.44728 •00000 •00115	•44779 •00000 •00091	•44814 •00000 •00074	•44959 •00000 •00013	•44996 •00000 •00001	•00000 •00000	•45000 •00000 •00000	•45000 •00000 •00000	•45000 •00000 •00000	•45000 •00000 •00000	•45000 •00000 •00000	•45000 •00000 •00000
				R =	0.50. F	PERCENT I	ULL = 20	0.12, U	/F = 3.96	8	,			
Pressure, 1b/sq in. abs Temperature, ^O K	600.00 2944	500+00 2866	428•57 2800	375 • 00 2742	338 • 88 2699	150•00 2356	60.00 1990	30.00 .737	15.00 1507	14.70 1501	6.00 1238	3.00 1059	0•60 720	0•30 606
H O	0.01447 .00009	0.01778	0.01057 •00004	0.00921 -00003	0.00002 .49438	0.00282 .00000	0.00053 .00000 .49962	0.00010 -00000		0.00001 .00000 .49999	0.00000 0.00000 0.50000	0.00000 .00000 .50000	0.00000 •00000 •>0000	0 • 00000 • 00000 • 50000
H ₂ H ₂ 0	•49042 •49024 •00003	-49180 -49207 -00002	.49268 .49342 .00002	.4937b .4944b	•49516 •00001	•49865 •49865	-49980 -00000	45997	•50000 •00000	•>0000	•50000 •00000	•50000 •00000	•50000	•50000
0H	•00475	•00377	•00307	•00253	•00218	•00050	•00005	•00001	•00000	•00000	•00000	•00000	•00000	•00000
				· · · · ·	0.60. F	PERCENT P	TUEL = 17	7.35, 0,	/F = 4.76		<u> </u>			I
Pressure, 1b/sq in. abs Temperature, ^O K	600•00 3208	500.00 3137	428.57 3077	375 • 00 3025	342 • 61 2990	150 • 00 2669	60.00 2313	30+00 2050	15.00	14.70	6+00 1506	3 • 00 1306	916	0+30 778
H O	0.32778 .30069 .36651	 • 0∩054 	0.02282 •00043	00035 36916	0.01970 .00030	0.00988 -00006 -39432	0.00321 .00000 .39800	•00000 •39935	0.00023 .00000 .39985	•00000 •3998>	*000002 *00000 *39999	0.00000 .00000 .40000	0.00000 00000 40000	0.00000 .00000 .40000
H2 H2O O2	.38651 .56831	.30751 .57250 .00032	.38839 .57980 .0026	.57840 .07821	.5801b	.59191 .00004	•59796 •00000	-59948 -50000	•39990 •30000	•00000	•59999	•60000	•60000 •00000	•60000
OH 02	•01629	•01406	01230	-01088	•00998	•00379	•00031	•00017	•00002	•00002	•00000	•00000	• 20000	•00000
				R =	0.70, F	PERCENT !	FUEL = 15	5.25. U,	/F = 5.55	1	Γ——			
Pressure, 1b/sq in. abs Temperature, oK	600•00 5381	500.00 5017	428.57 3263	375.00 321?	345.24 3166	150.00 2903	60•00 2>64	30.00 2337	15.00 2088	14.70 2081	6.00 1775	3.00 1550	0.60	0+30 966
н	• 03771 • 00268	0.03524 -00229	•00199	003135 003175 29315	0.03028 .00161 .29309	0.01959 .00058	0.00964 -00011 -29565	0.00443 .00002 .29779	0.00156 -00000	0.00151 .00000 .29917	0.00025 000000 29965	0.00004 .00000 .29997	• 00000	•00000 •30000
H ₂ H ₂ O O ₂ OH	.29362 .62760 .01229	•24370 •63436 •00197 •04263	.00179 .00179	•64449 •00155 •02759	•64727 •00143 •02637	•67154 •67154 •00054 •01420	•6890b •60011 •00026	•69594 •00002 •00180	.c9806 .00000	.69890 .00000 .00042	•00000	•69998 •00000	•70000 •00000 •00000	• 70000 • 00000 • 00000
OH	1 .03230	L • 0 12 9 3	T • 2544.3	102/37	1 .02037	1 -01450	1 -00720	1 -00100	-0.70-**	1 -000-2	55567	1 -00000	L.: 55000	

TABLE IV. - Concluded. EQUILIBRIUM COMPOSITION OF PRODUCTS OF REACTION AT ASSIGNED PRESSURES FOR LIQUID HYDROGEN AND LIQUID OXYGEN

(d) Concluded. Combustion-chamber pressure, 600 pounds per square inch absolute

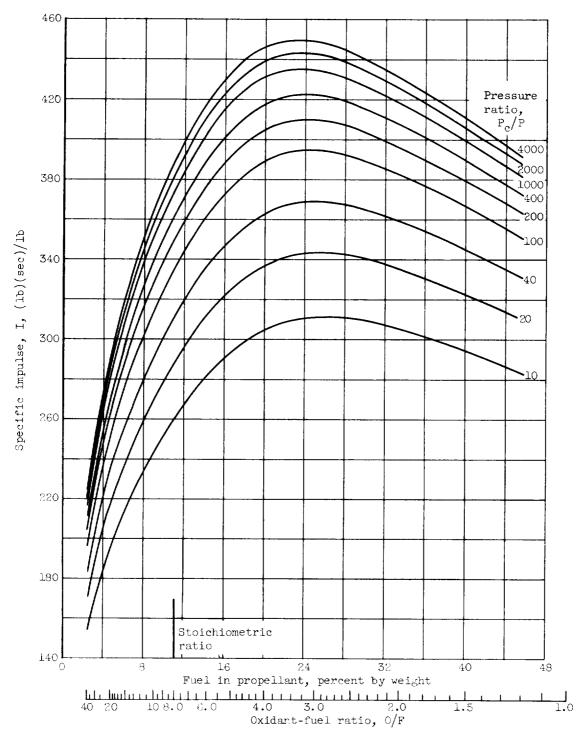
			-	R =	0.80. F	PERCENT F	FUEL = 1:	3.60.	0/	F = 6.34	9				
Pressure, 1b/sq in. abs Temperature, OK	600.00 3481	500+00 3422	428•57 3373	375 • 00 3331	346+81 3305	150•00 3052	60+00 2779	3 .		15 • 00 2346	14+70 2340	6+00 4044	3+00 1815	0+60 1347	0+30 11/3
н	0.04117	0.03913	0.03742	0.03595		0.02609	0.01678	0.0.0		0.00538	0.00526	0.00149	0.00040	0.00001	0.00000
0 Ho	•00646 •21839	.00584 .21659	•00534 •21509	•00492 •21301	•0046B •2130B	•00250 •20598	•20057	•000 •198	69	.00007 .19855	*18829 *00009	.19938	•00000 •19981	•20000	•2000o
н ₂ н ₂ 0	.66670	•67542	.68269 .00678	.68890 .00635	.69250 .00610	•72890 •00359	•76212 •00147	• 780 • 01:0		.79211 .00011	•79235 •00011	•79845 •00001	•79968 •00000	00000	•80000 •00000
0H 05	.00786 .05941	•00727 •05575	.05269	05006	.04854	+03294	•01813	•0:9		.00378	•00366	•00056	•00011	•00000	•00000
				R =	0.90, F	ERCENT F	 	2 • 28	0/	F = 7.14	3				
Pressure, lb/sq in. abs Temperature, OK	600+00 3526	500+00 3469	428.57 3422	375 • 00 3382	347+52 3360	150+00 3122	60+00 2881		00 05	15.00 2528	14.70 2523	6 • 00 4279	3 • 00 2072	0 • 60 1585	0+30 1397
н	0.03919	0.03743	0.03596	0.03469	0.03398	0.02643	0-01890				0.00910			0+00007	0+00001
0	.01130 .16146	•01053 •15871	.00989 .15636	•00935 •15433	•00905 •15316	•00604 •14025	+00342 +12644	•001 •16	93	.10852	*00086	*00017 *10171	•00002 •1000>	•00000 •09997	•00000 •10000
H20	.68792	.69763	.70580	.71285	.71686	.76023	·80490	-8-5	71	.66232	-86302	+88712	+89611	.89993	.89999
H20 H20 OH	.01917 .08096	.01845 .07727	.01782 .07417	•01727 •07150	.01695 .06999	•01322 •05383	•00890 •03743	•0:5 •0:6	70 14	.00292 .01614	+00285 +01587	•00064 •00605	•00009 •00190	•00003	•00000
				R =	1.00 F	PERCENT I	1 FUEL = 11	1.19.	0/	F = 7.93	7	I			
Pressure, lb/sq in. abs Temperature, OK	600+00 3534	500•00 3478	428.57 3431	375.00 3392	347•72 3370	150+00 3137	60+00 2903	30 • 27		15.00 2578	14.70 2573	6+00 2371	3+00 2214	0.60 1826	0+30 1648
H	0.03443	0.03281	0.03146	0.03030	0.02966	0.02281	0.01615	0.0 1	77	0.00802	0+00792 +00286	0.00417	0.00216	0-00018 -00004	0.00003
0 H ₂	• 31593 • 12040	•01504 •11731	•01430 •11467	•01368 •11237	•01334 •11107	•09622	•07953	.0 6	69	05387	•05349	.03741	•02591	.00641	-00244
H ₂ 0	.69574	.70566	.71402	.72125	.72534	•77027 •03159	.81775 .02737	.8 2 .0 3		.88474 .01983	.88567 .01971	•94390 •01437	•94942 •01027	.98868 .00274	.99587 .00108
1120 02 011	.03662 .09689	•03605 •09314	•03555 •08999	•03510 •08729	.03484 .08577	•06934	-05267	•0 1	11	.03063	•03034	-01877	.01159	.00195	•000>B
				R =	1.50. F	ERCENT I	UEL = 7	749	0/	F = 1.90	5				
Pressure, 1b/sq in. abs Temperature, OK	600.00 3374	500.00 3315	428.57 3267	375 • 00 3226	346.93 3202	150 • 00 2953	60•00 2692	3 14	00 96	15•00 2297	14•70 2291	6.00 2026	3 • 00 1816	0.60 1366	0+30 1195
н	0.01276	0.01175	0.01093	0.01023	0.00984	0.00606	0.00299	0 • 0 - 1	46		0+00055	0.00009	0.00001	0.00000	0.00000
0 H ₂	+02263 +03486	•02121 •03285	•02002 •03117	•01902 •02972	•01844 •02889	•01265 •02032	•00739 •01216	•0⊞4 •0⊞7	20	00211	•00206 •00351	•00056 •00098	•00014 •00025	•00000	•00000
H ₂ O	.65376	.66167	.66829	.67395	.67722	.71084	•74322	.7:.3	58	77939	•77979	.79254	•79729	•79990 •19996	•79998 •19999
02 0H	.16978 .10621	.17119 .10133	.17238 .09722	.17340 .09368	.17399 .09163	.18014 .06998	•18637 •04787	.1 0 .0 2		.19418 .02016	•19427 •01983	.19760 .00823	•19904 •00326	•00014	•00002
	L	l	l	R =	2.00, F	PERCENT I	FUEL = 5.	927	0/	F = 5.87	3				
Pressure, 1b/sq in. abs Temperature, OK	600 • 00 3158	500+00 3097	428•57 3046	375 • 00 3002	345•45 2975	150-00 2706	60•00 2413	3.1	89 00	15•00 1965	14•70 1959	6 • 00 1678	3•00 1475	0•60 1070	0+30 923
н	0.00439 .01610	0.00387 .01461	0.00345 .01339	0.00311 .01238	0.00271 .01178	0+00132 +00648	0.00039 .00260	0.0:0	11	0.00002	0.00002 000028	0.00000	0.00000	0.00000	0.00000 000000
O Ho	+01269	•01157	•01065	•0098B	•00942	•00529	-00218	.00		.00025	•00024	•00003	•00000	•00000	-00000
H ₂ 0	•58773	•59371	.59864	-60281	.60532 .30765	.62843 .31693	.64767 .32491	.6 7 .3 9	28	.66285 .33154	.66296 .33159	.66584 .33293	.66647 .33324	.66666	.66667
H ₂ H ₂ O O ₂ OH	•30070 •07838	•30305 •07319	•30500 •06887	•30665 •06517	•06293	•04155	•02225	•0 i		•00505	•00491	•00116	•00028	•00000	•00000
		<u> </u>		R =	3.00+ F	ERCENT !	UEL = 4	031	0/	F = 3.81	0				
Pressure, 1b/sq in. abs Temperature, OK	600+00 2747	500+00 2679	428.57 2622	375•00 2573	340+99 2538	150+00 2237	60+00 1913	3 6	00 82	15•00 1470	14.70 1464	6 • 00 1220	3 • 00 1053	0+60 733	0+30 622
н	0.00046	0.00036	0.00028	0.00023	0.00020	0.00004	0.00000	0+0:0	00		0.00000	0.00000		0.00000	0.00000
0 H ₂	•00474 •00191	•00392 •00159	•00330 •00135	•00282 •00116	•00251 •00103	•00075 •00032	•00012 •00005	•0 0	01	•00000 •00000	•00000 •00000	•00000	•00000	•00000	-00000
H20	•47624	.47934	.48178	.48375	•48507	•49370	.49827 .49895	• 4. 9	51	.49989 .49993	49990	.49999 .49999	•50000	•>0000 •>0000	•50000 •50000
02 0H	• +8500 • 03164	•48699 •02780	.48855 .02474	.48981 .02224	•49065 •02055	•49611 •00909	•00261	•4 9 •0 0	77	.00017	-00016	•00001	•50000	+00000	•00000
				R =	4.00 F	ERCENT F	I	054	0/	F = 1.74	6	L	I	l	L
Pressure, 1b/sq in. abs Temperature, °K	600+00 2381	500•00 2309	428.57 2249	375.00 2198	336•49 2157	150.00	60+00 1554		00 48	15+00 1164	14.70 1159	6.00 952	3.00	0.60	0+30 463
н	0.00004	0.00002	0.00002	0.00001		0.00000	0.00000	0.0 0	00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0 Н2	• 00094 • 00026	•00019	•00015	•00011	•00009	-00001	•00000	• 0 · 0	00	•00000	•00000	•00000	•00000	•00000	•0000n
H ₂ 0	•39338	•39465 •59618	•39559 •59686	•39629	•39680 •59774	•39910 •59938		•3 9 •5 9		.40000 .60000	•40000 •60000	•40000 •60000	•40000 •60000	•40000 •60000	•40000 •60000
05 04	•59523 •01015	•00826	•00687		•00503	•00145				•00000	•00000		•00000	•00000	•00000
	L	·	·	R =	5.00, F	PERCENT I	UEL = 2	458	0/	F = 9•68	3	•			
Pressure, lb/sq in. abs Temperature, K	600-00 2072	500+00 2002	428.57 1944	375+00 1894	333•54 1852	150+00 1578	60+00 1303	3 1	0 0 22	15•00 961	14.70 956	6+00 777	3+00 658	0+60 438	0•30 365
0	0.00014	0+00009	0.00006	0+00005	0.00003	0.00000					0.00000			0.00000	0.00000
H ₂	• 20003 • 33163	•00002 •33205	•00001 •33234	+30001 +33235	•00001 •33270	•00000 •33321	•00000 •33332	.0 0	33	.33333	•00000 •33333	•00000 •33333	•00000 •33333	•00000 •33333	و د د د د د
H20 02 0H	.66538	.66571	.66593	•6650d	•66£30	-66658		-6-6	67	.66667	•66667	.66667	•66667	•66667	•66667
LAT	•00282	•00212	•00165	•00131	•00107	•00021	•00002	-0 0	UU	•00000	•00000	•00000	•00000	•00000	•00000

TABLE V. - SUMMARY OF COMBUSTION PARAMETERS, CHARACTERISTIC VELOCITY, AND PERFORMANCE
FOR EXPANSION TO SEA LEVEL FOR LIQUID HYDROGEN WITH LIQUID OXYGEN

								,		,
Equiv-	Fuel, percent	Oxidant- fuel	Com- bus-	Ex1t tem-	Charac- teristic	Charac- teristic-	Entropy,	Area ratio,	Coeff1- cient	Specific impulse,
ratio.	by	weight	tion	pera-	veloc-	velocity	s, cal	ratio,	of	
R, 2(0)/H	weight	ratio,	tem-	ture.	1ty.	exponent,	(g)(°K)		thrust,	(1b)(sec)
2(0)/H		O/F	pera-	T _e ,	c*, ft/sec	n _e *	,		$c_{\mathbf{F}}$	16
			ture,	°K	10/860					
			o _K]			
СН	AMBER PR	ESSURE,	60 POUN	IDS PER	SUUARE I	NCH ABSULU	TE, EUUIL	IBRIUM	COMPOSIT	ION
0.150	45.65	1.190	1183	819	1247	0.0000	9.3807	1.244	1.038	233.7
• 200	38.65	1.587	1514	1075	7607	•0000	8.5172	1.256	1.035	244.7
• 250	33.51	1.984	1016	1316	7814	•0000	7.8147	1.268	1.033	250.8
• 300 • 350	29.57 26.47	2.381	2329	1546 1764	7930 7988	•0000 •0001	6.7611	1.278	1.029	254•1 255•4
	200	24110			1,700	•0001	00,011	10207	1.02/	l
•400	23.95	3.175	2001	1970	0001	•0009	6.3590	1.302	1.027	455.3
•450 •500	21.87	3.968	2676	2159 2327	7973 7912	•0045 •0045	0.0167	1.316	1.025	254.0 251.8
•600	17.35	4.762	3015	2066	7129	.0080	202415	1.354	1.023	245.7
•700	15.25	5.556	3179	2756	7508	.0105	4.8659	1.369	1.022	238.6
.800	13.60	6.349	3188	2848	7277	.0119	4.5644	1.376	1.022	231.2
• 900	12.20	7.143	3213	2888	70>4	.0125	4.3169	1.379	1.022	224-1
1.000	11.19	7.937 11.905	3217	2896	6846 6061	•0126 •0169	4.1101 2.4371	1.380	1.022	217.5 192.6
2.000	2.921	15.875	2706	2099	2220	.0067	3.0653	1.368	1.022	176.4
3.000	4. 643	23.416	,,,,	المدر		001.0		1. 220	1.034	156.0
3 • 000 4 • 000	4.031 3.034	23.810 31.746	2000	1851	4866 4366	•0040 •0009	2.6610	1.339	1.025	154.8 139.2
>.000	2.458	39.683	2062	1571	3912	.0001	2.2965	1.295	1.029	127.0
CH4	MBER PHI	SSURF	50 POUN	DS PER	SULLARF I	NCH ABSULU	TE • EGHT!	LERTUM	COMPOSIT	I On
0.150	47.65	1.190	1103	639	1241	0.0000	8.7684	1.997	1.261	284+0
• 200 • 250	38.65 35.51	1.587	1514	1052	7607 7814	•0000 •0000	7.5120	2.033	1.261	298+2 306+6
• 300	29.57	2.381	2092	1251	1929	.0000	6.9718	2.111	1.264	311.5
• 350	26.47	2.778	2339	1444	7988	•0000	6.5215	2.147	1.265	314.0
• 400	23.95	3.175	2553	1631	8006	•0005	6.1415	2.182	1.266	315.0
• 450	21.87	3.571	2733	1812	7988	.0016	5.81/0	2.221	1.267	314.7
•500	20.12 17.35	3.968 4.762	70A1	1986 2300	/940 7782	•0068	5.5371 5.0787	2.352	1.270	313+3 308+4
• 700	15825	2.556	3231	2500	1571	•0095	4.7193	2.425	1.280	301.4
* 0.0	12.40	- 260	4.00	2677	7355	.0110	4.4299	2.472	1.282	293+2
• 800	13.60	7.145	3304	2770	7134	•01/3 •01/1	4.1919	2.493	1.284	284.6
1.000	11.19	7.937	3341	2700	6925	.0122	3.9926	2.498	1.284	276.4
2.000	7.749 5.927	11.905 15.873	3219 3045	2621 2382	6120 5592	•0103	3.3416 2.9807	2.474	1.283	244.0
2.000	7.721	12.013	3043	2302	33,92	•0079	2.07607	2.421	1.200	222.4
3.000	4.031	23.810	2695	1907	4882	•0032	2.5869	2.301	1.272	193.0
4.000 5.000	3.054 2.458	31.746	2363 2066	1549 1298	4369 3972	•0007 •0000	2.3706	2.215	1.267	172•1 156•3
СНА	MBER PRE	.SSURE # 31	30 POUN	DS PER	SQUARE II	NCH ABSOLUT	LE. FOUIL	IRKIOM (COMPUSIT.	LON
0.150	40.60		1163	229	1241	0.0000	8.6565	3.020	1.379	310+6
• 200 • 250		1.190								
	38 65	1.587	1014	700	7607	•0000	7.9040	3.068	1.382	326.7
•300	38.65 33.51 29.57				1929 1813 1813		7.49040 7.2831 5.7696	3.000 3.160 3.240	1.382 1.386 1.390	326.7 336.5 342.5
00د. 05د.	38.65 35.51	1.587	1514 1517	700 884	7813	•0000 •0000	7.2831	3.160	1.386	336.5
	38.65 33.51 29.57	1.587 1.984 2.381	1514 1617 2093	1059 884 705	7813 1929	•0000 •0000 •0000	7.2831 5.7596	3.160 3.246 3.325	1.386	336.5 342.5
• 350 • 400 • 450	38.65 33.51 29.57 26.47 23.95 21.07	1.587 1.984 2.381 2.778 3.175 3.271	1914 1817 2093 2344 2965 2755	702 884 1059 1234 1403 1569	7813 1929 7988 8008 7996	.0000 .0000 .0000 .0000	7.2831 6.7696 6.3404 5.9772 5.6664	3.160 3.240 3.320 3.320 3.399 3.474	1.386 1.390 1.393 1.397 1.401	336.5 342.5 345.9 347.6 348.1
• 400 • 450 • 200	38+65 33-51 29-57 26-47 23-95 21-67 20-12	1.587 1.984 2.381 2.778 3.175 3.175 3.571 3.968	1914 1817 2093 2344 2969 2799 2915	702 882 1029 1232 1403 1269 1732	7813 /y2y 7988 8008 /yy6 /y56	0000 0000 0000 0000 0000 0012	7.2831 5.7696 6.3404 5.9772 5.6664 5.3976	3.160 3.240 3.329 3.399 3.474 3.553	1.386 1.390 1.393 1.397 1.401 1.405	336.5 342.5 345.9 347.6 348.1 347.5
• 350 • 400 • 450	38.65 33.51 29.57 26.47 23.95 21.07	1.587 1.984 2.381 2.778 3.175 3.271	1914 1817 2093 2344 2965 2755	702 884 1059 1234 1403 1569	7813 1929 7988 8008 7996	.0000 .0000 .0000 .0000	7.2831 6.7696 6.3404 5.9772 5.6664	3.160 3.240 3.320 3.320 3.399 3.474	1.386 1.390 1.393 1.397 1.401	336.5 342.5 345.9 347.6 348.1
• 350 • 400 • 450 • 500 • 600 • 700	38.65 33.51 29.57 26.47 23.95 21.67 20.12 17.35 15.25	1.587 1.984 2.381 2.778 3.175 3.271 3.968 4.762 5.556	1514 1617 2093 2344 2565 2755 2915 3155 3307	709 882 1099 1232 1403 1569 1732 2047 2328	7813 /929 7988 8008 /996 /956 /816 7625	.0000 .0000 .0000 .0000 .0003 .0012 .0025 .0058	7.2831 6.7696 6.3404 5.9772 5.6664 5.3976 4.9564 4.6094	3.168 3.248 3.329 3.399 3.474 3.553 3.726 3.900	1.386 1.390 1.393 1.397 1.401 1.405 1.416 1.426	336.5 342.5 345.9 347.6 348.1 347.5 347.5 343.9 337.9
. 350 . 400 . 450 . 500 . 600 . 700 . 800 . 900	38.65 33.51 29.57 26.47 23.95 21.67 20.12 17.35	1.587 1.984 2.381 2.778 3.175 3.571 3.968 4.762	1914 1817 2093 2344 2965 2795 2915 3155	702 882 1029 1232 1403 1269 1732 2047	7813 /y29 7988 8008 /yy6 /y56 7816	.0000 .0000 .0000 .0000 .0003 .0012 .0025	7.2831 6.7696 6.3404 5.9772 5.6664 5.3976 4.9564	3.160 3.240 3.329 3.399 3.474 3.553 3.726	1.386 1.390 1.393 1.397 1.401 1.405 1.416	336.5 342.5 345.9 347.6 348.1 347.5 343.9
.350 .400 .450 .500 .600 .700 .800 .900	38.65 33.51 29.57 26.47 23.95 21.67 20.12 17.35 15.25 13.60 12.28 11.19	1.587 1.984 2.381 2.778 3.175 3.175 3.571 3.968 4.762 5.556 6.349 7.143 7.937	1914 1817 2093 2344 2969 2799 2915 3195 3430 3437	702 882 1029 1232 1403 1259 1732 2047 2328 2544 2661	7813 / y29 7988 8006 / y96 / 956 7816 7625 7411 7193 6983	.0000 .0000 .0000 .0000 .0002 .0025 .0025 .0087 .0107 .0117	7-2831 5-7696 6-3404 5-9772 5-6664 5-3976 4-9564 4-6094 4-3293 3-9046	3.168 3.248 3.329 3.399 3.474 3.553 3.726 3.900 4.042 4.121 4.140	1.386 1.390 1.393 1.397 1.401 1.405 1.416 1.426 1.433 1.437 1.438	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 312.0
.350 .400 .450 .500 .600 .700 .800 .900 1.000	38.65 33.51 29.57 26.47 25.47 21.67 20.12 17.35 15.25 13.60 12.28 11.19 7.749	1.587 1.984 2.381 2.778 3.175 3.271 3.968 4.762 5.556 6.349 7.143 7.937 1.993	1914 1817 2093 2344 2965 2755 2915 3195 3395 3430 3430 3437 2297	702 802 1029 1232 1403 1269 1732 2047 2328 2544 2661 2687	7813 / 729 7900 8000 / 7950 / 7810 7610 7620 7411 / 193 0103	.0000 .0000 .0000 .0000 .0002 .0012 .0025 .0058 .0087	7-2831 5-7696 5-3404 5-9772 5-6664 4-9564 4-6094 4-3293 4-6945 3-9045 3-2701	3.168 3.248 3.329 3.399 3.474 3.553 3.726 3.726 3.900 4.021 4.140 4.121 4.140	1.386 1.390 1.393 1.397 1.401 1.405 1.416 1.426 1.433 1.437 1.438 1.434	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 350.1 321.2 312.0 214.6
.350 .400 .450 .500 .600 .700 .800 .900 1.000 1.500 2.000	38.65 33.51 29.57 26.47 23.95 21.67 20.12 17.35 15.25 13.60 12.28 11.19 7.749 5.927	1.587 1.984 2.381 2.778 3.175 3.571 3.968 4.762 5.556 6.349 7.143 7.993 1.905 15.873	1914 1817 2093 2344 2965 2715 3105 3107 3430 3437 3297 1163	702 882 1023 1232 1403 1252 2047 2328 2544 2661 2667 2472 2181	7813 / y28 8000 / y96 / y / y9	.0000 .0000 .0000 .0000 .0012 .0025 .0056 .0087 .0107 .0117 .0118 .0097	7-2831 5-7696 5-3404 5-9772 5-6664 5-3976 4-9564 4-6094 4-3293 4-0983 3-9046 3-2701 2-917	3.168 3.248 3.329 3.399 3.474 3.553 3.726 3.726 3.900 4.042 4.121 4.140 4.028 3.918	1.386 1.390 1.393 1.397 1.405 1.405 1.426 1.433 1.435 1.435 1.436 1.436	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 312.0 24.6 249.2
.350 .400 .450 .500 .600 .700 .800 .900 1.500 2.000	38.65 33.51 29.57 20.47 23.95 21.07 20.12 17.35 15.25 15.60 12.28 11.19 1.149 5.927 4.031	1.587 1.984 2.381 2.778 3.175 3.271 3.964 4.762 5.556 6.349 7.143 7.937 1.997 1.9873	1914 1817 2093 2344 2755 2715 3105 3307 3430 3430 3430 3430 3430 3430 3430	702 882 1025 1235 1403 1732 2047 2328 2544 2661 2472 2181 1678	7813 /7286 8000 /770 /790 /810 7625 7411 7193 9103 9103 9103	.0000 .0000 .0000 .0000 .0002 .0025 .0025 .0087 .0117 .0118 .0097 .0072	7-2831 6-7696 6-3404 5-9772 5-6664 5-3976 4-9564 4-6094 4-3293 4-0983 5-2701 2-917.	3.168 3.248 3.329 3.379 3.474 3.553 3.726 3.900 4.042 4.140 4.028 3.918	1.386 1.390 1.393 1.397 1.401 1.405 1.416 1.426 1.433 1.437 1.438 1.434 1.434	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 312.0 214.6 249.2
.350 .400 .450 .500 .600 .700 .800 .900 1.000 1.500 2.000	38.65 33.51 20.57 20.47 23.47 20.47 23.47 20.12 17.35 17	1.587 1.984 2.381 2.778 3.175 3.571 3.9968 4.762 5.556 6.349 7.143 7.937 11.905 12.873 23.810	1914 1817 2093 2344 2705 2715 3105 3107 3430 3437 3193 3437 3193 3437 3193	702 882 1032 1232 1403 1305 1732 2047 2328 2544 2661 2472 2181	7813 / Y296 8000 / Y960 / Y960 / 7810 7625 7411 / 1793 0 903 0 0 0 0 0 0 003 0 003 0 003 0 003 0 003 0 003 0 003 0 003 0	.0000 .0000 .0000 .0000 .0000 .0005 .0012 .0025 .0087 .0117 .0118 .0097 .0072	7-2831 5-7696 6-3404 5-9772 5-6664 5-3976 4-9564 4-6094 4-3293 4-9983 3-9046 3-2701 2-9117 2-9310 2-310 2-310	3.168 3.24b 3.32p 3.33y 3.474 3.553 3.726 3.900 4.042 4.121 4.140 4.140 4.038 3.918	1.346 1.390 1.393 1.397 1.401 1.405 1.446 1.426 1.435 1.437 1.438 1.434 1.434 1.434	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 312.0 24.6 249.2
.350 .400 .420 .500 .600 .700 .800 1.000 1.500 2.000 4.000 5.000	38abb 33-51 24-57 26-47 23-95 21-67 20-12 17-35 15-25 11-25 11-25 11-19 12-24 11-19 12-24 13-004 2-45b	1.9d7 1.984 2.381 2.77e 3.175 3.90e 4.762 5.556 6.349 7.997 11.907 11.907 23.010 31.74e 39.083	1014 1017 2093 2344 2065 2795 3155 3155 3155 3430 3430 3437 3163 2277 2163 2172 2069	702 882 1039 1232 1403 1752 2047 2328 2544 2801 247/2 2181 1678 1343 1117	7813 /727 7988 8000 /790 /950 /810 7625 7411 /1193 0783 5103 5041 4094 4371 3972	.0000 .0000 .0000 .0000 .0000 .0002 .0012 .0025 .0047 .0117 .0118 .0097 .0072	7-2851 0-7696 0-3404 5-9772 5-6604 4-9564 4-6094 4-3293 4-9293 3-9046 3-2701 2-9171 2-9310 2-3183 2-1794	3.168 3.229 3.329 3.474 3.555 3.700 4.042 4.121 4.140 4.140 4.140 3.918 3.918 3.634 3.474 3.388	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.438 1.427 1.438 1.426 1.439	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 312.0 244.6 249.2 214.4 190.2 172.4
.350 .400 .420 .500 .600 .700 .800 1.000 1.500 2.000 4.000 5.000	38abb 33-51 24-57 26-47 23-95 21-67 20-12 17-35 15-25 11-25 11-25 11-19 12-24 11-19 12-24 13-004 2-45b	1.9d7 1.984 2.381 2.77e 3.175 3.90e 4.762 5.556 6.349 7.997 11.907 11.907 23.010 31.74e 39.083	1014 1017 2093 2344 2065 2795 3155 3155 3155 3430 3430 3437 3163 2277 2163 2172 2069	702 882 1039 1232 1403 1752 2047 2328 2544 2801 247/2 2181 1678 1343 1117	7813 /727 7988 8000 /790 /950 /810 7625 7411 /1193 0783 5103 5041 4094 4371 3972	.0000 .0000 .0000 .0000 .0000 .0005 .0012 .0025 .0087 .0117 .0118 .0097 .0072	7-2851 0-7696 0-3404 5-9772 5-6604 4-9564 4-6094 4-3293 4-9293 3-9046 3-2701 2-9171 2-9310 2-3183 2-1794	3.168 3.229 3.329 3.474 3.555 3.700 4.042 4.121 4.140 4.140 4.140 3.918 3.918 3.634 3.474 3.388	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.438 1.427 1.438 1.426 1.439	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 312.0 2/4.6 249.2 214.4 190.2 172.4
.350 .400 .430 .500 .500 .700 .500 .700 .500 .2.000 .2.000 .500 .5000 .5000 .5000 .5000	38 ab 33 - 51	1.567 1.984 4.3961 2.776 3.177 3.571 3.986 4.762 5.556 6.349 7.143 7.997 7.143 7.190 11.900 23.810 31.768 35.810 31.768	1014 1017 2093 2344 2065 2705 3105 3105 3105 3430 3430 3431 3277 3103 2277 3103 2272 2069	702 882 1022 1232 1403 1254 1732 2047 2328 2544 2601 2412 2181 1078 1343 1117	7613 1729 7966 6006 1796 1796 1795 1795 1795 1795 1795 1795 1795 1795	-0000 -0000 -0000 -0000 -0000 -0005 -0058 -0057 -0117 -0118 -0057 -0072 -0000 -0000	7-2891 0-7090 0-3404 5-9772 5-65664 5-3976 4-9564 4-6094 4-6094 4-9293 3-9761 2-9310 2-1794 2-5310 2-1794 3-2460 6-3440	3.160 3.275 3.325 3.325 3.325 3.726 3.726 3.726 3.900 4.042 4.140 4.050 3.910 3.910 3.910 4.140	1.346 1.393 1.393 1.397 1.401 1.416 1.426 1.433 1.434 1.438 1.438 1.439 1.430 1.400 1.396	340.5 342.5 345.9 347.6 348.1 347.5 347.5 347.5 347.5 347.5 347.9 337.9 337.9 337.9 327.6 249.2 249.4 249.2
.350 .400 .450 .500 .600 .700 .800 .700 1.500 2.000 3.000 6.000 5.000 CHA	38 60 3 3 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.56/ 1.944 2.381 2.778 3.179 3.57/ 3.968 4.762 5.556 6.349 7.143 7.937 11.900 15.87/ 39.683 39.683 5.50RE. 60	1914 1917 2093 2344 2969 2915 3109 3430 3430 3431 3297 3103 2177 3103 2179 2179 2179 2189 2189 2189 2189 2189 2189 2189 218	702 882 1023 1232 1403 1252 1732 2047 2328 2544 2661 2472 2161 1678 1343 1117 25 PER	7dL3 /929 7908 0000 /990 /990 /990 /910 /903 /903 /903 /903 /903 /903 /903 /90	.0000 .0000 .0000 .0000 .0000 .0002 .0025 .0058 .0087 .0117 .0118 .0097 .0007 .0005 .0000	7-2891 0-7090 0-3404 3-9772 3-6064 4-9564 4-9564 4-6094 3-9040 3-9040 3-9040 3-1794 2-1794	3-160 3-243 3-322 3-322 3-322 3-323 3-726 3-900 4-042 4-140 4-028 3-910 3-910 3-634 3-388 IENIUM (4-602 4-602	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.428 1.426 1.400 1.400 1.396 0.00PUSITI	336.5 342.5 345.9 347.6 348.1 347.5 348.1 347.5 337.9 330.1 321.2 249.2 249.2 249.2 2172.4
.350 .400 .450 .500 .600 .700 .700 .900 1.000 1.000 1.000 2.000 4.000 5.000 .700 .700 .700 .700 .700 .700	38 ab 33 - 51	1.56/1 1.984 2.301 2.776 3.176 3.271 3.986 4.762 5.556 6.349 7.143 7.997 11.903 12.66/3 2.3010 31.746 35.8083 SSURE, 6(1014 1017 2093 2344 2065 2705 3105 3105 3105 3430 3430 3431 3277 3103 2277 3103 2272 2069	702 882 1022 1232 1403 1254 1732 2047 2328 2544 2601 2412 2181 1078 1343 1117	7613 1729 7966 6006 1796 1796 1795 1795 1795 1795 1795 1795 1795 1795	-0000 -0000 -0000 -0000 -0000 -0002 -0025 -0026 -0017 -0118 -0027 -0072 -0005 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000 -0000	7-2891 0-7090 0-3404 0-3404 0-3404 0-3406	3.160 3.275 3.325 3.325 3.553 3.726 3.553 3.726 3.900 4.042 4.140 4.140 4.140 4.140 4.140 3.910 3.910 3.910 3.910 3.910 4.000	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.428 1.427 1.428 1.427 1.420 1.400 1.396	340.5 342.5 345.9 347.6 348.1 347.5 347.5 347.5 347.5 347.5 347.9 337.9 337.9 337.9 327.6 249.2 249.4 249.2
- 350 - 400 - 450 - 200 - 600 - 700 - 800 - 900 1 - 200 2 - 000 2 - 000 CHA	38 e b 3 3 5 1 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2	1.56/ 1.944 2.381 2.778 3.179 3.57/ 3.968 4.762 5.556 6.349 7.143 7.937 11.900 15.87/ 39.683 39.683 5.50RE. 60	1014 1017 2093 2344 2007 2715 3105 3105 3107 3430 3437 3277 2277 2103 2123 2009 1014 1014	702 882 1029 1232 1403 1732 2047 2328 2044 2661 2661 2661 2181 1678 1343 1117 25 PER	7613 1729 7966 6006 1796 1796 1795 1795 1719 1719 1719 1719 1719 1719	.0000 .0000 .0000 .0000 .0000 .0002 .0025 .0058 .0087 .0117 .0118 .0097 .0007 .0005 .0000	7-2891 0-7090 0-3404 3-9772 3-6064 4-9564 4-9564 4-6094 3-9040 3-9040 3-9040 3-1794 2-1794	3.160 3.275 3.325 3.325 3.553 3.726 3.553 3.726 3.900 4.042 4.140 4.140 4.140 4.140 4.140 3.910 3.910 3.910 3.910 3.910 4.000	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.428 1.426 1.400 1.400 1.396 0.00PUSITI	330.5 342.5 345.9 347.6 347.6 347.5 347.5 347.5 347.9 337.9 330.1 321.2 312.0 249.2 219.2 219.2 219.2 219.2 219.2 219.3
.350 .400 .500 .500 .700 .800 .700 1.500 2.000 2.000 5.000 4.000 .200 .200 .200 .350 .350	38.60 33.01 27.07 26.47 23.47 23.47 20.12 17.35 15.25 11.60 12.28 12.28 12.29 13.004 2.450 38.60	1.56/ 1.944 2.381 2.778 3.17> 3.57/ 3.988 4.762 5.556 6.349 7.143 7.947 11.903 23.810 31.776 33.888 5.50Re. 60	1914 1917 2093 2344 2963 2793 3135 3135 3393 3430 3437 3103 2277 3103 2123 2009 1014 1017 2014 1017 2014 1017 2014	709 882 1097 1232 1403 1792 2047 2328 2544 2881 2981 1078 1343 1117 25 PEA 491 1049	7613 7429 7900 0000 7900 07900 7900 7910 7910 79	0000 0000 0000 0000 0000 0001 00012 00025 00087 00107 0117 0118 0007/ 0000 0000 0000 0000 0000 0000	7-2891 0-7090 0-3404 5-977/2 5-6064 4-9564 4-9564 4-6094 3-9040 3-2701 2-9170 2-9170 2-9174 2-5310 2-1794 2-5310 2-1794 2-6-944 6-9440 7-6-959 7-6-959 6-1594	3-160 3-240 3-320 3-320 3-320 3-320 3-503 3-726 3-918 3-	1.346 1.393 1.393 1.393 1.401 1.401 1.426 1.427 1.428 1.424 1.426 1.400 1.396 1.410 1.400 1.396 1.414 1.414 1.426 1.426 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.427 1.426 1.426 1.426 1.426 1.427 1.426 1.427 1.426	330.5 342.5 345.9 347.6 348.1 347.5 338.1 337.9 330.1 321.2 311.0 24.6 249.2 21.4 190.2 172.4 UN
.350 .400 .500 .500 .700 .800 .700 .800 .700 .700 .800 .700 .7	38 60 33 - 51 2 - 52 - 52 - 52 - 52 - 52 - 52 -	1.567 1.944 2.381 2.778 3.177 3.571 3.968 4.762 5.556 6.349 7.16-3 7.997 11.900 15.673 23.081 31.746 39.083 5.50RE. 60	1914 1917 2093 2344 2965 2795 3105 3105 3430 3430 3437 3437 3437 3437 3437 3437	103 1037 1232 1403 1732 2047 2328 2544 2661 247 247 247 2181 1678 1343 1117 25 PER	7613 7427 7408 6000 7408 7629 7613 7621 7641 7690 7631 7641 7690	0000 0000 0000 0000 0000 0001 0002 0005 0008 0017 0118 0007 0007 0000 0000 0000 0000 0000 0000	7-2891 0-7090 0-3404 5-977/2 5-6064 4-9564 4-9564 4-6094 3-9040 3-904	3-160 3-240 3-320 3-320 3-320 3-503 3-503 3-503 3-503 4-121 4-140 4-124 4-140 4-124 3-910 3-534 3-910 3-534 3-910 4-602 4-602 4-602 4-602 4-602 4-602 4-602	1.346 1.393 1.393 1.393 1.397 1.401 1.401 1.426 1.427 1.428 1.427 1.426	336.5 342.5 345.9 347.6 348.1 347.5 337.9 330.1 321.2 32.2 32
- 350 - 400 - 400 - 700 - 700 - 700 1 - 900 1 - 900 2 - 900 4 - 900 - 200 -	38460 39-01 29-07 20-07	1.56/ 1.944 4.381 2.778 3.171 3.968 4.762 5.556 6.349 7.149 11.900 11.56/ 3.9083 5.5083 5.5083 5.5083 5.746 3.7683 5.778 3.179 3.778	1914 1817 2093 2344 2755 3155 3155 3155 3155 3430 3430 3430 3430 3430 3430 3430 34	100 100	7613 7729 7706 3000 7790 6000 7950 7625 7411 7193 90903 9050	00000 00000 00000 00000 00000 00000 0000	7-2891 0-7090 0-3404 3-9712 3-90604 3-976 4-9964 4-0994 3-906 3-2701 2-3103 2-1794 2-3103	3-168 3-249 3-329 3-379 3-474 3-553 3-726 3-972 4-141 4-140 4-058 3-914 3-918 3-914 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-602 4-605 6-701	1.346 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.438 1.427 1.438 1.427 1.438 1.440 1.400 1.396 1.410 1.404 1.404 1.404 1.405 1.404 1.405	330.5 342.5 345.9 347.6 340.1 340.1 340.1 331.9 337.9 330.1 321.2 249.2 172.4 UN 330.9 348.6 359.6 359.6 370.9 370.9
.350 .400 .450 .200 .600 .700 .800 .700 .1000 .200 .200 .200 .200 .200 .200 .	38.60 33.51 27.57 26.47 23.47 23.47 26.12 17.35 15.25 11.14 7.47 4.031 5.054 2.456 33.51 24.57 25.57 26.47 25.47 26.47	1.567 1.944 2.361 2.776 3.771 3.968 4.762 5.556 6.349 7.143 7.943 7.1490 11.900 10.673 23.810 31.776 39.685 5.597 2.381 2.381 2.381 2.381 2.381 2.381 2.381 2.381 2.381 2.381 2.381 2.381 2.394 4.762	1914 1817 2093 2344 2752 2715 3307 3430 3430 3430 3431 247 2062 2072 2072 2072 2074 2074 2074 2074 207	100 100	7613 7929 8000 8000 7940 8000 7940 7623 7411 7193 903 903 904 8092 4371 9972 7613 7629 8010 8001 7900	0000 0000 0000 0000 0000 0001 0001 000	7-2891 0-7090 0-3404 D-9772 D-06064 D-3970 4-9564 4-0094 4-0983 3-9704 2-9716 2-9716 2-1794 2-2819 2-1794 2-2819 2-1794 2-2819 2-1794 2-2819 2-1794 2-2819 2-281	3-160 3-240 3-329 3-379 3-474 3-503 3-726 3-910 3-910 3-918 3-	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.428 1.427 1.428 1.426 1.400 1.396 1.400 1.396 1.409	330.5 342.5 345.9 347.5 348.1 347.5 348.1 347.5 348.1 321.2 311.4 321.2 311.4 190.2 17
- 350 - 400 - 400 - 700 - 700 - 700 1 - 900 1 - 900 2 - 900 4 - 900 - 200 -	38460 39-01 29-07 20-07	1.56/ 1.944 4.381 2.778 3.171 3.968 4.762 5.556 6.349 7.149 11.900 11.56/ 3.9083 5.5083 5.5083 5.5083 5.746 3.7683 5.778 3.179 3.778	1914 1817 2093 2344 2755 3155 3155 3155 3155 3430 3430 3430 3430 3430 3430 3430 34	100 100	7613 7729 7706 3000 7790 6000 7950 7625 7411 7193 90903 9050	0000 0000 0000 0000 0000 0001 0001 000	7-2891 0-7090 0-3404 3-9712 3-90604 3-976 4-9964 4-0994 3-906 3-2701 2-3103 2-1794 2-3103	3-160 3-240 3-329 3-379 3-474 3-503 3-726 3-910 3-910 3-918 3-	1.346 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.438 1.427 1.438 1.427 1.438 1.440 1.400 1.396 1.410 1.404 1.404 1.404 1.405 1.404 1.405	330.5 342.5 345.9 347.6 340.1 340.1 340.1 331.9 337.9 330.1 321.2 249.2 172.4 UN 330.9 348.6 359.6 359.6 370.9 370.9
.350 .400 .450 .200 .600 .700 .800 .700 .800 .200 .200 .200 .200 .200 .250 .25	38605 33-51 24-7 25-47 26-47 23-47 20-12 17-35 15-25 1-60 14-25 1-19 1-19 1-19 1-19 1-19 1-19 1-19 1-1	1.567 1.944 2.381 2.778 3.173 3.571 3.968 4.762 5.556 6.349 7.149 11.900 11.873 23.810 31.746 33.883 33.883 1.997 1.994 2.381 2.778 3.179	1914 1817 2093 2344 2705 2715 3105 3107 3437 2477 3103 2123 2372 2007 1813 1914 1914 2947 2947 2947 2947 2947 2944 2947 2944 3208 3301	100 100	7613 7427 7406 6000 7440 7620 7411 7119 9403 9403 9503	00000 00000 00000 00000 00000 00000 0000	7-2891 0-7090 0-3404 3-9712 3-60604 3-3976 4-9964 4-9963 3-9046 3-2701 2-3103 2-1794 2-5103 2-1794 2-6012 1-601	3-168 3-249 3-329 3-379 3-474 3-553 3-726 3-926 4-042 4-140 4-058 3-916 3-916 4-160 4-058 3-916 5-106 5-106 5-106 5-106 5-106 5-106 6-107 6-107 6-107 6-107	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.428 1.424 1.426 1.430 1.400 1.396 1.410 1.400 1.396 1.410 1.400 1.396 1.410 1.426 1.427 1.428 1.426 1.426 1.427 1.428 1.426 1.426 1.426 1.427 1.428 1.426	330.5 342.5 345.9 347.6 347.6 347.6 348.1 347.5 348.1 347.5 348.1 347.5 348.1 347.5 348.1 34
.350 .400 .400 .500 .500 .700 .800 .700 1.000 2.000 2.000 2.000 2.000 .5000 CHA 0.150 .250 .300 .350 .400 .250 .300 .350 .600 .700 .700	38.60 33.51 27.07 20.47 23.47 21.67 20.12 17.37 15.25 13.60 14.28 11.19 1.428 11.19 1.428 11.19 1.428 11.19 1.428 1.19 1.428 1.19 1.428 1.19 1.428 1.19 1.428 1.407 2.408 33.51 29.57 20.47 20.12 11.67 20.12 20.1	1.567 1.984 2.381 2.776 3.175 3.271 3.986 4.762 5.556 6.349 7.143 7.993 11.900 12.673 23.810 31.763 39.683 39.683 3.913 3.913 3.913 3.913 3.913 3.913 3.913 3.913 3.913 3.913 3.913 3.913 3.914	1914 1817 2093 2344 2709 2715 3105 3430 3430 3430 3431 2277 3103 2103 2004 2004 2004 2014 1817 2014 1817 2014 2014 2014 2014 2014 2014 2014 2014	100 100	7613 7729 7706 6000 7790 7610 7629 7411 7193 6703 7621 4671 3772 SUUAKE 17 7613 7740 6001 7740 6001 7769 7769 6010 6001 7769 7769 6010 6001 7769 7769 6010 6001 7769 7769 6010 6001 7769 7769 6010 6010 7769 7769 6010 7769 6010 7769 7769 7769 6010 7769 7	0000 0000 0000 0000 0000 00012 00025 00058 00087 01107 01108 00072 0000 0000 0000 0000 0000 0000 0	7-2891 0-7090 0-3404 0-3404 0-3404 0-3404 0-3406	3-160 3-240 3-329 3-3720 3-5726 3-726 3-726 3-726 3-910 4-121 4-121 4-121 4-121 4-121 4-121 4-121 4-121 3-910 3-910 3-910 4-121	1.346 1.393 1.397 1.401 1.405 1.416 1.426 1.426 1.428 1.424 1.400 1.396 1.400 1.396 1.417 1.468 1.417 1.468 1.494 1.400 1.396 1.417 1.468 1.494 1.495	330.5 342.5 345.9 347.6 346.1 347.5 34
.350 .400 .450 .200 .600 .700 .800 .700 .800 .200 .200 .200 .200 .200 .250 .25	38.60 33.51 27.07 20.47 23.47 20.12 21.67 20.12 17.37 15.25 11.19 1.428 21.19 1.428 2.436 33.51 29.57 20.47	1.567 1.944 2.381 2.778 3.173 3.571 3.968 4.762 5.556 6.349 7.149 11.900 11.873 23.810 31.746 33.883 33.883 1.997 1.994 2.381 2.778 3.179	1914 1817 2093 2344 2705 2715 3105 3107 3437 2477 3103 2123 2372 2007 1813 1914 1914 2947 2947 2947 2947 2947 2944 2947 2944 3208 3301	100 100	7613 7427 7406 6000 7440 7620 7411 7119 9403 9403 9503	00000 00000 00000 00000 00000 00000 0000	7-2891 0-7090 0-3404 0-3404 0-3404 0-3404 0-3406 0-3406 0-3406 0-3406 0-3406 0-3406 0-3607 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-2	3-168 3-249 3-329 3-379 3-474 3-553 3-726 3-926 4-042 4-140 4-058 3-916 3-916 4-160 4-058 3-916 5-106 5-106 5-106 5-106 5-106 5-106 6-107 6-107 6-107 6-107	1.346 1.393 1.393 1.397 1.401 1.405 1.416 1.426 1.427 1.428 1.424 1.426 1.430 1.400 1.396 1.410 1.400 1.396 1.410 1.400 1.396 1.410 1.426 1.427 1.428 1.426 1.426 1.427 1.428 1.426 1.426 1.426 1.427 1.428 1.426	330.5 342.5 345.9 347.6 347.6 347.6 348.1 347.5 348.1 347.5 348.1 347.5 348.1 347.5 348.1 34
.350 .400 .450 .200 .600 .700 .800 .900 1.000 2.000 .200 .200 .200 .250 .350 .000 .200 .350 .000 .200 .350 .000 .200 .350 .300 .300 .300 .300 .300 .300 .3	38.60 33.01 24.07 26.47 23.49 24.07 20.12 17.30 10.25 11.60 12.28 11.19 7./4031 30.054 2.450 38.60 33.51 29.57 20.47 20.12 11.60 11.	1.567 1.944 2.381 2.778 3.177 3.571 3.968 4.762 5.556 6.349 7.163 7.997 11.900 10.873 23.610 31.776 33.768 1.190 1.567 1.994 2.381 2.778 3.179 3.179 3.178 3	1914 1817 2093 2344 2709 2715 3105 3105 3430 3430 3431 2477 3103 2007 2007 2007 2007 2007 2007 2007 20	100 100	7613 7929 7908 6000 7909 7919 7919 7919 7919 7919 7919 7	0000 0000 0000 0000 0000 0012 0025 0035 0037 0117 0118 0007 0000	7-2891 0-7090 0-3404 3-9712 3-60604 3-3976 4-9964 4-9963 3-9046 3-2701 2-3103 2-310	3.168 3.29 3.329 3.379 3.474 3.553 3.726 3	1.346 1.393 1.397 1.401 1.405 1.416 1.426 1.433 1.434 1.436 1.436 1.448 1.440 1.400 1.396 1.416 1.400 1.396 1.416 1.400 1.396 1.410 1.400 1.396 1.410 1.400 1.396	330.5 342.5 345.9 347.6 347.6 347.6 348.1 347.5 348.1 347.5 348.1 347.5 348.1 347.5 348.1 34
.350 .400 .400 .500 .700 .800 .700 .800 .900 .1.000 .2.000 .2.000 .250 .200 .250 .200 .250 .200 .250 .200 .250 .200 .250 .200 .250 .25	38.60 33.51 27.07 20.47 21.67 20.12 17.35 15.25 13.60 14.28 11.19 1.428 11.19 1.429 2.450 MGCR PRC 43.60 38.60 33.51 29.57 26.47 25.47 25.47 25.47 25.47 25.47 25.47 25.47 25.47 26.47 27.	1.567 1.984 2.381 2.776 3.175 3.571 3.988 4.762 5.556 6.349 7.143 7.997 11.900 10.867 2.381 2.778 3.176 3.176 2.381 2.778 3.176 3.162 3.162 3.176 3.17	1914 1817 2093 2344 2755 3155 3155 3430 3437 3430 3437 3297 1103 2123 2005 2123 2005 2123 2005 2123 2005 2123 2005 2123 2005 2123 2005 2123 2005 2005 2005 2005 2005 2005 2005 20	100 100	7613 7729 7706 3000 7790 3000 7790 7610 7627 7411 7193 9090 9103 9040 9070	0000 0000 0000 0000 0000 00012 00025 00087 0117 0118 00072 0000 0000 0000 0000 0000 0000 00	7-2891 0-7090 0-3404 0-3404 0-3404 0-3404 0-3406 0-3406 0-3406 0-3406 0-3406 0-3406 0-3607 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-200 0-1000 0-2	3-168 3-24 3-329 3-379 3-474 3-553 3-726 3-926 4-140 4-140 4-028 3-918 3-474 3-388 ERIUM (4-602 4-602 4-602 4-602 4-602 6-602 6-949 5-704 6-947 7-024 6-760	1.346 1.393 1.397 1.401 1.402 1.416 1.426 1.433 1.427 1.438 1.424 1.400 1.396 0MPUSITI 1.409 1.404 1.400 1.506 1.507 1.502 1.507 1.504	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 330.1 321.2 214.6 249.2 214.6 249.2 172.4 UM 330.9 330.9 359.6 359.6 359.6 374.5
- 350 - 400 - 400 - 400 - 700 - 800 - 700 - 1000 1 - 100 2 - 000 2 - 000 - 200 - 200 - 200 - 350 - 400 - 350 - 400 - 700	38.60 33.51 24.07 26.47 21.67 20.12 17.35 15.25 13.50 14.28 11.19 1.428 11.19 1.428 11.19 1.428 11.19 1.428 11.19 1.428 11.19 1.428 2.430	1.567 1.984 2.381 2.776 3.175 3.988 4.762 5.556 6.349 7.143 7.193 11.900 10.873 23.810 2.778 3.1746 3.	1914 1817 1019 2344 2755 2715 3125 3125 3125 3430 3431 2277 1103 2123 2004 2123 2004 2123 2004 2123 2004 2123 2004 2123 2004 2123 2004 2014 2123 2004 2014 2014 2014 2014 2014 2014 2014	100 100	7413 7796 3000 7796 3000 7796 3000 7796 7411 7193 9103 9103 9103 9103 9103 9103 9103 9	0.0000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000	7-2891 0-7090 0-3404 0-3404 1-3406	3-166 3-24 3-329 3-379 3-474 3-573 3-726 3-7	1.346 1.393 1.397 1.401 1.402 1.416 1.426 1.433 1.427 1.438 1.424 1.400 1.396 0MPUSITI 1.409 1.404 1.400 1.506 1.507 1.502 1.507 1.504	336.5 342.5 345.9 347.6 348.1 347.5 343.9 337.9 300.1 321.2 312.0 249.2 249.2 219.2 172.4 UM 330.9 359.5 369.6 370.9 374.5 374.7
- 350 - 400 - 500 - 600 - 700 - 1000 - 1000 - 1000 - 1000 - 2000 - 20	38.60 33.01 27.07 26.47 23.47 24.07 26.47 23.47 26.12 17.35 15.25 11.19 7.40 4.031 3.0054 2.456 35.01 2.456	1.567 1.944 2.381 2.778 3.177 3.988 4.762 5.556 6.349 7.143 11.903 11.907 1.56	1914 1817 2093 2344 2965 2705 3105 3307 3430 3430 3430 247 247 247 247 2574 2574 2574 2574 257	100 100	7413 7908 4000 7909 6010 7909 7411 7193 9001 9001 7629 7417 7417 7417 7417 7417 7417 7417 741	00000 00000 00000 00000 00000 00000 0000	7-2891 0-7090 0-3404 1-3772 1-3976 1-3976 1-4-5091 1-3103 1-31	3-166 3-24 3-329 3-379 3-474 3-573 3-726 3-7	1.346 1.393 1.393 1.393 1.497 1.401 1.402 1.427 1.438 1.427 1.438 1.426 1.400 1.396 1.410 1.400 1.396 1.417 1.400 1.396 1.417 1.400 1.396 1.417 1.418 1.426 1.426 1.436 1.437 1.438 1.538	336.5 342.5 345.9 347.6 347.6 347.6 347.6 348.1 347.5 343.9 330.1 321.2 331.4 33

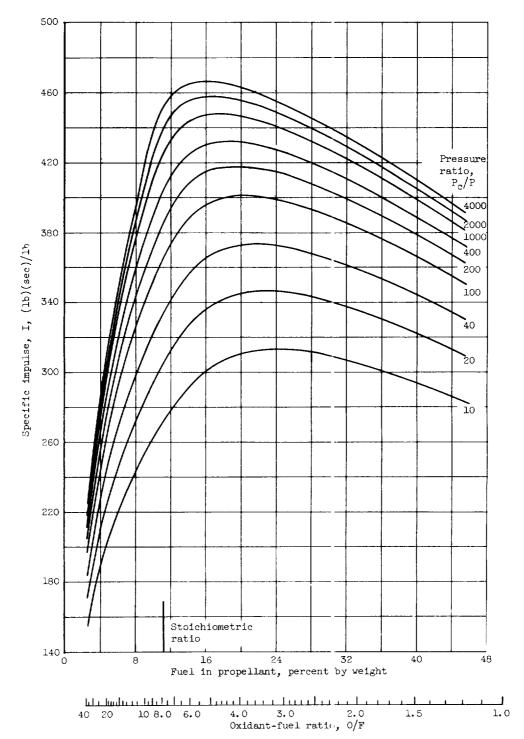
TABLE V. - Concluded. SUMMARY OF COMBUSTION PARAMETERS, CHARACTERISTIC VELOCITY,
AND PERFORMANCE FOR EXPANSION TO SEA LEVEL FOR LIGHTH HYDROGEN WITH LIQUID OXYGEN

e ron	EXTAI	IDION I	U SE	W TE	EL FOR	/ DIA:OI	ווח ע	JRUGEN	WITH I
Equiv-	Fuel,	0x1dant-	Com-	Ex1t	Charac-		Area	Coeffi-	
ratio,	percent by	weight	bus- tion	tem- pera-	teristic	cal	ratio,	cient of	impulse,
2(0)/H	weight	ratio,	tem-	ture,		(g)(cK)		thrust,	(1b)(sec)
2(0)/H		0/F	pera- ture,	T _e ,	ft/sec			C _F	16
			T _c ,	°K	'				
			οĶ						
CH	AMBER PK	F C CLIMF .	AO PUIN	us PER	SUITARE I	NCH ALS.,	FROZEN	COMPUST	T 10N
			····						
0.150 .200	45.65 38.65	1.190	1183	1075	7247 7607	9.3507 8.5172	1.256	1.038	253.7
•250	33.51	1.984	1010	1313	/011	7.8347	1.467	1.033	250.8
•300 •350	29.57 26.47	2+381 2+778	2089	1540	7916 7948	7.2390 6.7611	1.278	1.032	253.8 254.6
		l					l	ļ.	
•400 •450	23.95	3.175	2531 2696	1912 2053	7922 7856	6.0167	1.292	1.030	253.5 251.3
•500	20.12 17.35	3.968 4.762	2828 3015	2166 2330	7763 7542	5.7222	1.301	1.029	248.2
•600 •700	15.25	5.556	3128	2429	7304	4.8659	1.307	1.028	241.0 233.3
•800	13.60	6.349	3188	2484	7070	4.5644	1.312	1.028	225.8
• 400	12.28	7-143	3613	2200	6000	4.5.67	1.515	1.028	218.8
1.000	11.19 7.749	7.937	3217	2514	5648 5891	4.1101 3.4071	1.313	1.027	212.3 168.1
4.000	5.927		2700	₹304	5401	3.0c33	1.511	1.058	172.5
3+000	4.031	23.810	2655	2040	4766	2.6610	1.305	1.028	152.3
4.000	3.054		2347	1789	4316	2.4399	1.298	1.029	138.1
5.000	2.458	ļ	2062	1254	3954	2.2965	1.292	1.030	126.6
CH	AMBER PR	ESSURE. 1	50 POUN	DS PEH	SOUARE I	NCH ABS.,	FRUZEN	COMPOSI	TION
0.150	45.65	1.190	1183	639	7247	8.9684	1.997	1.261	284.0
•200 •250	38.65 33.51	1.587	1514	847 1052	7607 7812	7.5120	2.033	1,261	298.2 306.5
• 300	29.57	186.2	2092	1240	7921	6.9718	2.110	1.264	311.2
• 350	26.47	2.770	2339	1430	7961	6.5,15	2.142	1.265	1.613
•400	23.95	3.175	2003	1594	7950	6.1415	2.168	1.267	313.0
•450 •500	20.12	3.968	2/53	1730 1846	7899 7821	5.0170 5.5:/1	2.189	1.268	311.2
•600	17.30	4.762	3097	2019	7621	5.gis7	2.228	1.269	300.7
+700	15.25	2.556	3231	2126	7395	4.7193	2.242	1.270	291.9
.800	13.60	6.349	3304	2190	7166	4.4299	2.251	1.271	283.0
.900 1.000	12.28	7.143	3336	2219	6947 6743	4.1519 3.9526	2.250	1.271	274.4
1.500	7.749	11.905	3219	2140	5965	3.3416	2.455	1.271	235.6
2.000	5.927	15.873	3045	2009	5458	2.9637	2.244	1-270	215.5
3.000	4.031 3.054	23.810 31.746	2695 2363	1745	4796 4329	2.5859	2.219	1.269	189.2 170.6
5.000	2.458	39.683	∠066	1284	3958	2.22.70	2.160	1.267	125.8
CHA	AMBER PH	LSSUKE, 3	O FUUN	US PER	SMUARE 1	NCH ADDER	FRUZEN	CUMPUSI	TIUN
0.150	40.60	1.190	1103	529	7247	8.6552	3.020	1.379	110.6
• 200	38.65	1.587	1514	100	7607	7 • 9C +O	3.048	1.38∠	326.7
• 250 • 300	33.51 29.57	1.984 2.381	2093	1057	7812 7923	7.2631 6.7676	3.167	1.386	336.5 342.2
0.350	26+47	2.778	2344	1223	7969	6.3434	3.519	1.394	345.1
•400	23695	3.175	2565	1376	7966	5.9112	3.380	1.397	345.8
•450 •500	21.67 20.12	3.571 3.968	2755	1511	7926 7858	5.66.34	3.431	1.399	344.7 342.3
•600	17.35	4.762	3100	1027	7675	4.95.74	3.550	1.404	335.0
• 700	10.25	2.250	70٪د	1922	/461	4.0074	3.267	1.406	326.1
.800	13.60	6.349	وبروو	1440	1237	4.52/3	3.590		316.6
1.000	12.28	7.143	3430	2023 2031	7019 6813	4.0733 3.70+6	3.604		298.3
1.000	7.749	11.90>	3241	1940	6017	3.27)1	3.547	1.408	203.4
2.000	5.927	15.873	3103	1804	5498	2.9171	3.269	1.406	240=4
3.000	4+031	23-810	2/23	1540	4816	2.5310	3.505	1.403	210.0 168.7
4.000 5.000	3.004 2.406		2372 2069	1304	433/ 3760	2.3113		1.397	171.9
CHA	MBER PR	SSUKE + 60	IO PUIN	US PEK	SWIIAKE II	NCH Ap i.e.	FKUZEN	CUMPUSIT	LIUN
0.150 .200	45.65 36.65	1.190	1183	437 585	7247 7607	8.34+6 7.6339		1.469	330.9 348.6
• 250	لدووو	1.984	2094	730 887	7613 7924	7.05+1	4.949	1.481	359.6 366.4
. 300 0 d t •	29.51	2.110	2347	1037	1924	6.15/4	5.104 5.252	1.488	370.3
• 400	23.75	3.1/5	2014	1101	1918	1118.0	5.384	1.499	371.6
• 450	21.5/	3.512	2113	1310	1947	2.21.0	5.491	1.504	371.5
•>00	17.35	3.900	2944 3203	160/	/890 /725	2.2512 4.63+7	5.730	1.508	369.7 363.3
•700	15.25	5.556	3200	1/34	1522	4.5012	5.821	1.517	354.6
• 500	13.60	6.144	. ۵۰۰	100/	7306	4.2214	5.876	1.519	344.9
• 900	12.20	7.143	3576 3534	1044	7089	4.00>6	2.906	1.520	335.0
1.000	11.17	7.937 11.905	33/4	1/50	507i		5.919	1.519	325.3 286.7
4.000	2.741	10.073	3123	1010	ە ۋد	2.85)7	>.dio	1.517	261.0
ئېن ₄ د	4.021	23.010	2147	1302	عرى،	1.41.6	5.06/	1.510	226.9
9.000	2+324 2+458	31.646 37.60;	2012	1127 947	9393 3962	2.12/0	2.521	1+502	203•1 184•6
		2.2007							



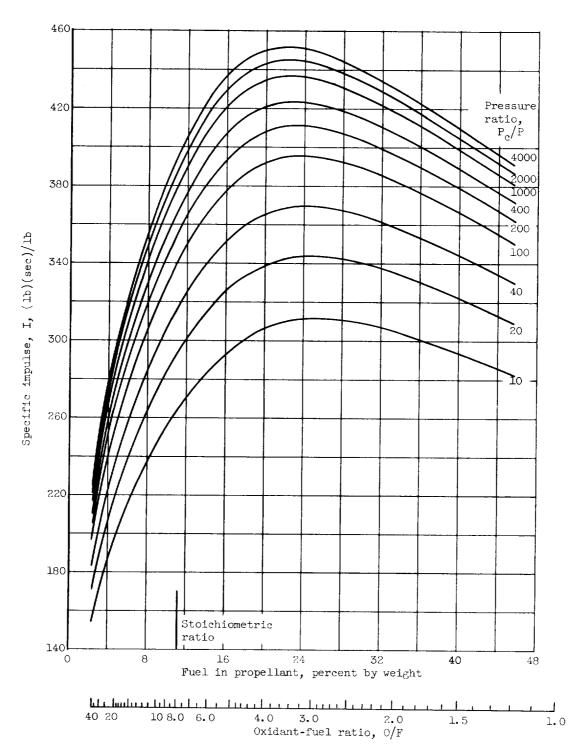
(a) Chamber pressure, 60 pounds per square inch absolute; frozen composition during expansion.

Figure 1. - Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



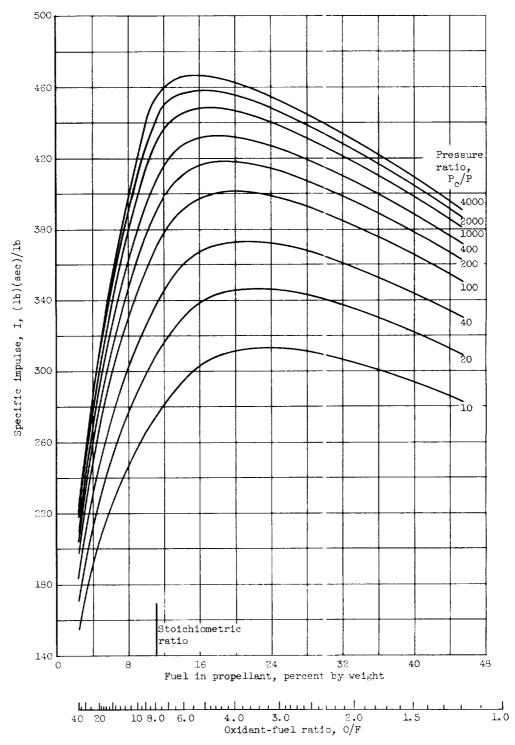
(b) Chamber pressure, 60 pounds per square inch absolute; equilibrium composition during empansion.

Figure 1. - Continued. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



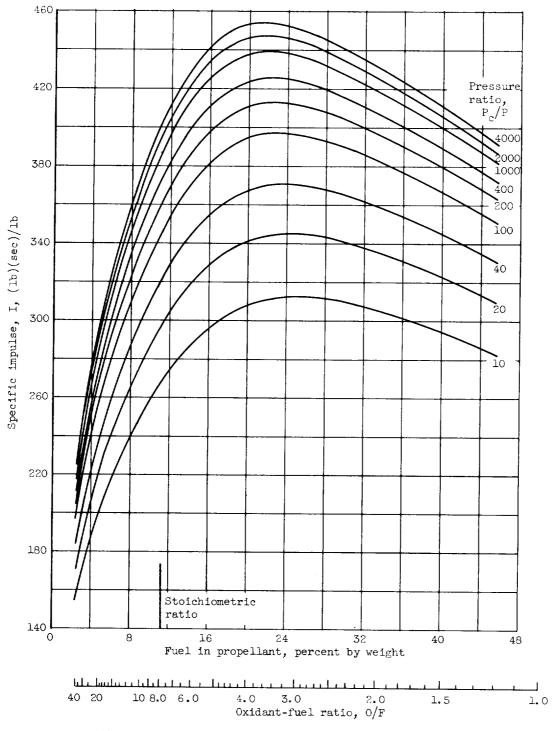
(c) Chamber pressure, 150 pounds per square inch absolute; frozen composition during expansion.

Figure 1. - Continued. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



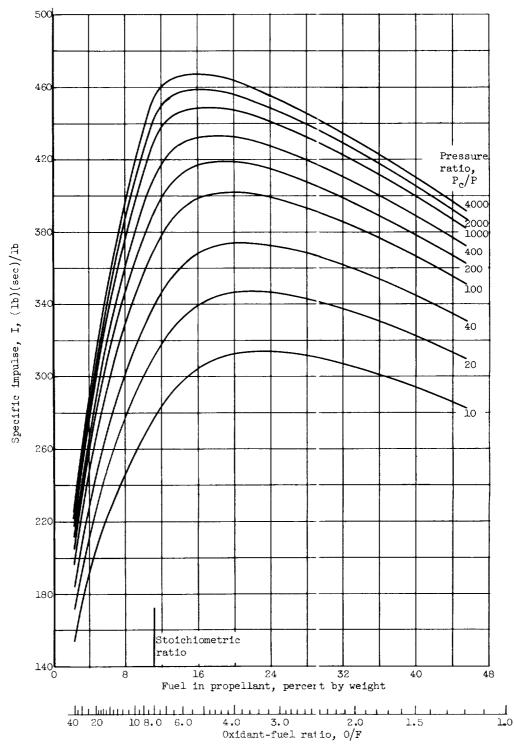
(d) Chamber pressure, 150 pounds per εquare inch absolute; equilibrium composition during exparsion.

Figure 1. - Continued. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



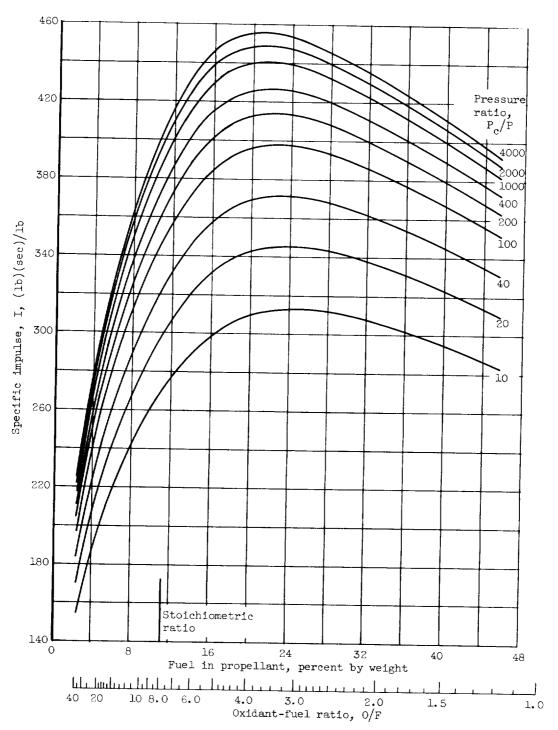
(e) Chamber pressure, 300 pounds per square inch absolute; frozen composition during expansion.

Figure 1. - Continued. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



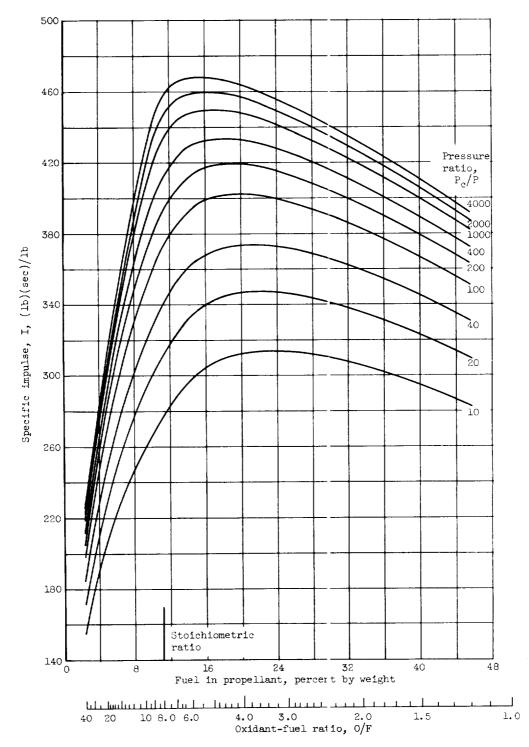
(f) Chamber pressure, 300 pounds per square inch absolute; equilibrium composition during expansion.

Figure 1. - Continued. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



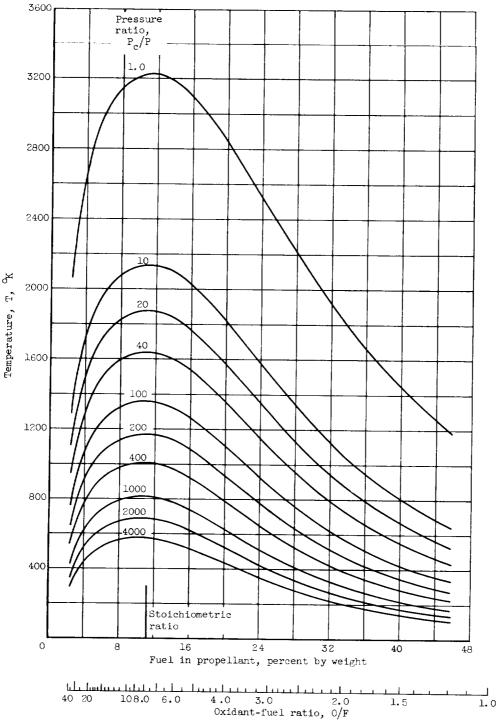
(g) Chamber pressure, 600 pounds per square inch absolute; frozen composition during expansion.

Figure 1. - Continued. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



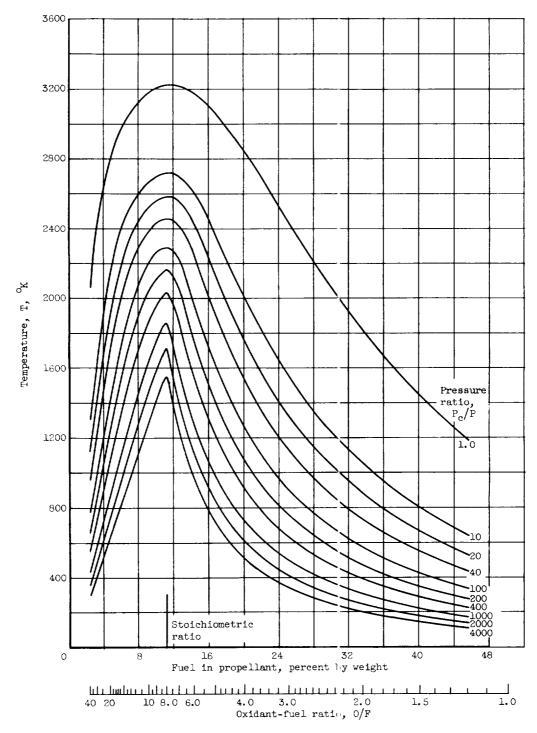
(h) Chamber pressure, 600 pounds per equare inch absolute; equilibrium composition during exparsion.

Figure 1. - Concluded. Theoretical specific impulse of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



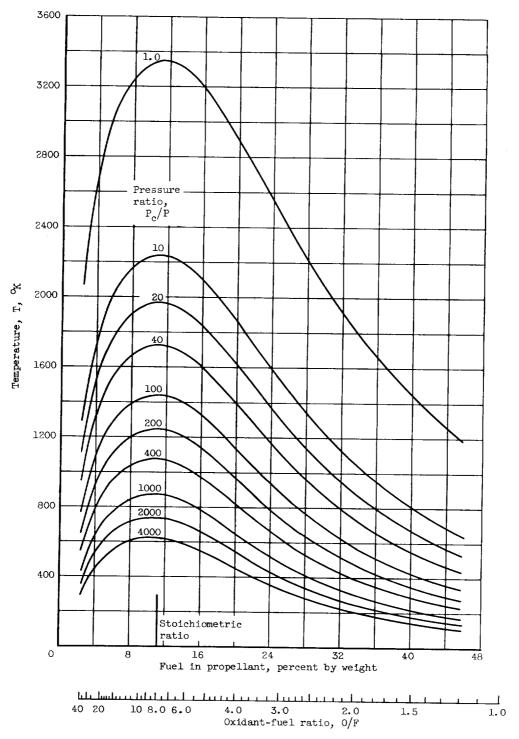
(a) Chamber pressure, 60 pounds per square inch absolute; frozen composition during expansion.

Figure 2. - Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



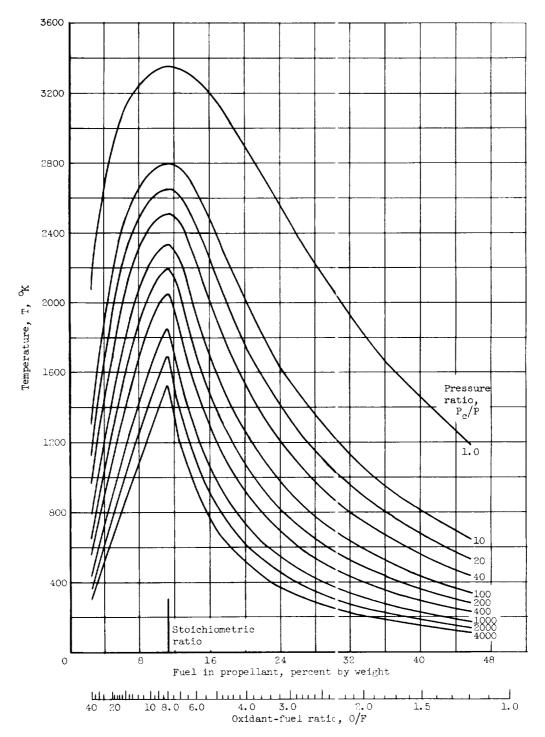
(b) Chamber pressure, 60 pounds per square inch absolute; equilibrium composition during expansion.

Figure 2. - Continued. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



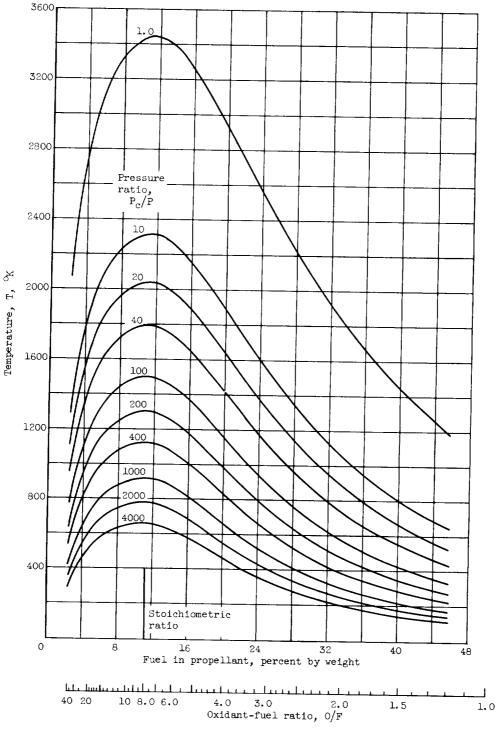
(c) Chamber pressure, 150 pounds per square inch absolute; frozen composition during expansion.

Figure 2. - Continued. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



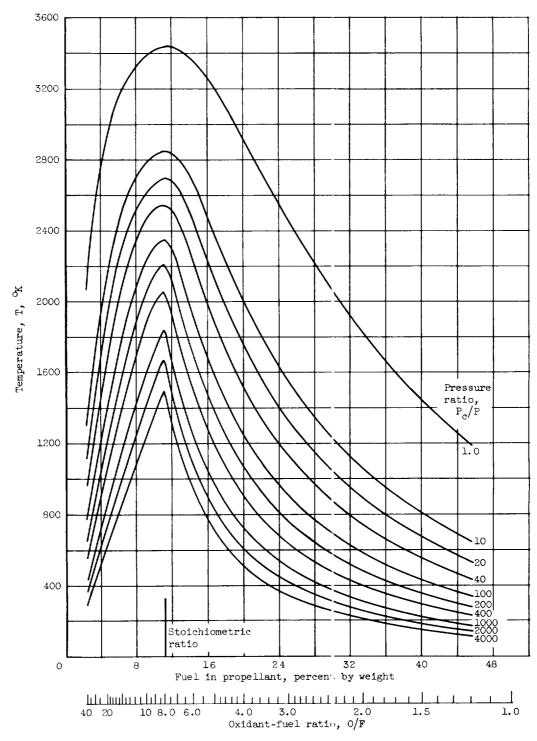
(d) Chamber pressure, 150 pounds per square inch absolute; equilibrium composition during expansion.

Figure 2. - Continued. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid cxygen. Isentropic expansion to pressure ratio indicated.



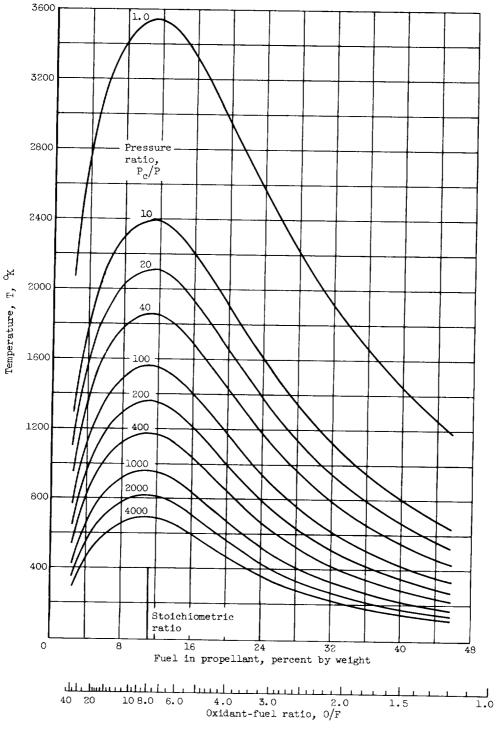
(e) Chamber pressure, 300 pounds per square inch absolute; frozen composition during expansion.

Figure 2. - Continued. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



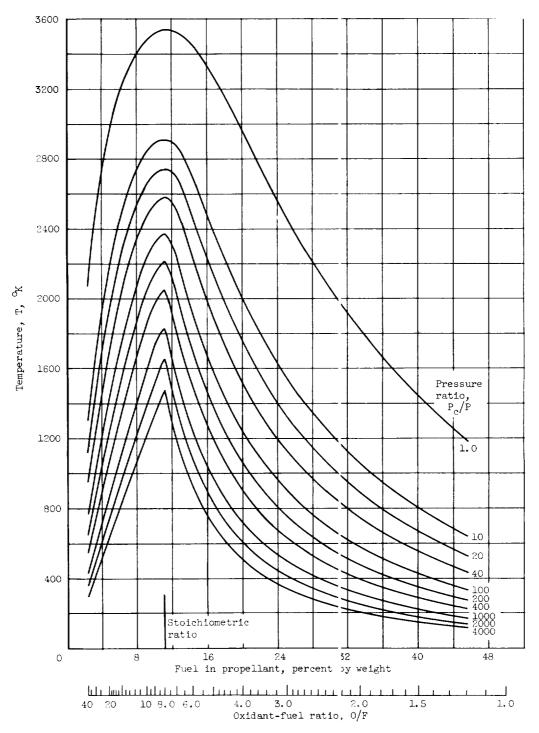
(f) Chamber pressure, 300 pounds per square inch absolute; equilibrium composition during expansion.

Figure 2. - Continued. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



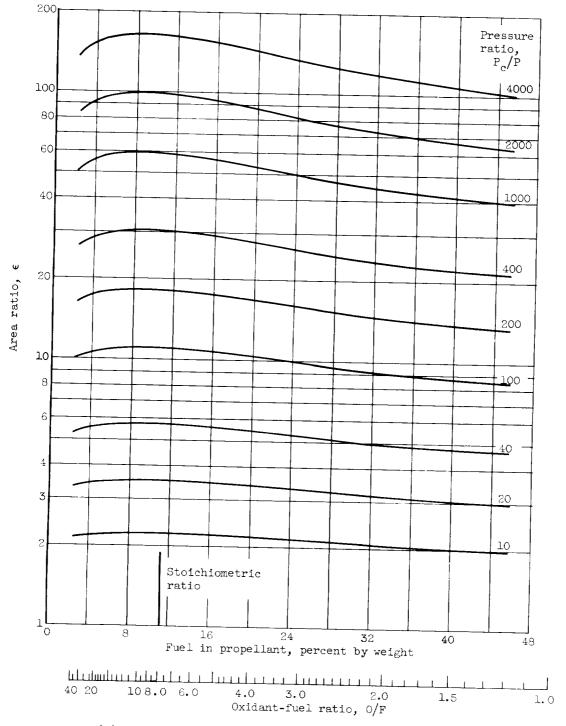
(g) Chamber pressure, 600 pounds per square inch absolute; frozen composition during expansion.

Figure 2. - Continued. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



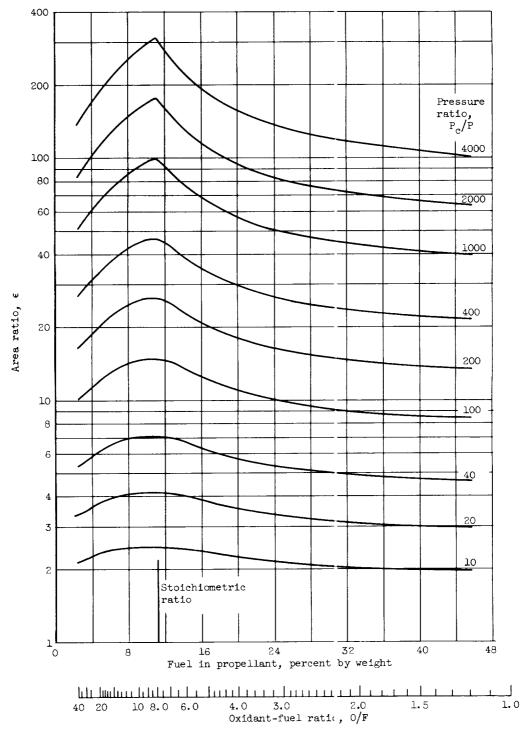
(h) Chamber pressure, 600 pounds per square inch absolute; equilibrium composition during expansion.

Figure 2. - Concluded. Theoretical combustion chamber and nozzle-exit temperatures of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



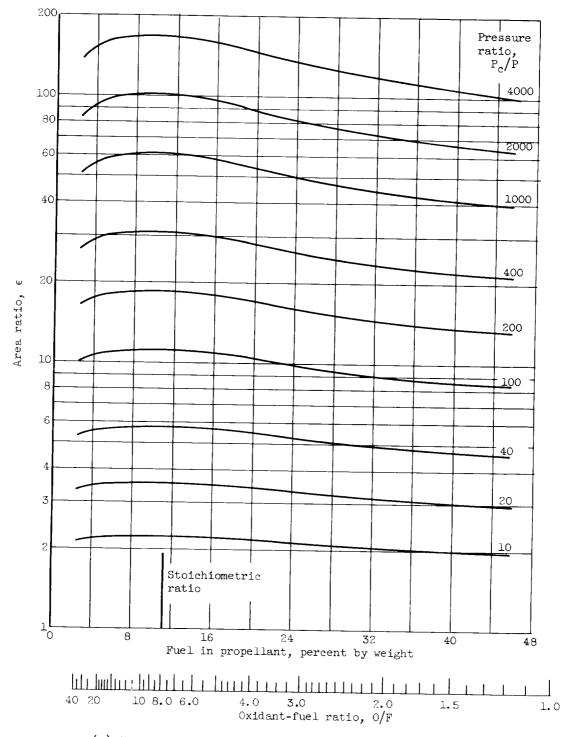
(a) Chamber pressure, 60 pounds per square inch absolute; frozen composition during expansion.

Figure 3. - Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



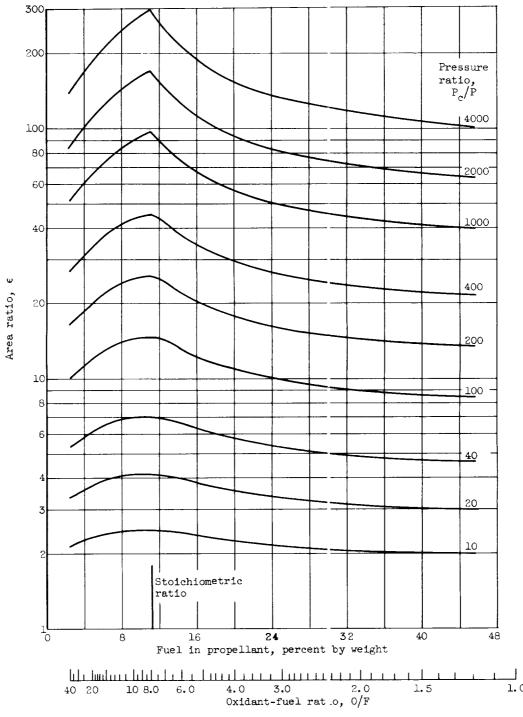
(b) Chamber pressure, 60 pounds per square inch absolute; equilibrium composition during expansion.

Figure 3. - Continued. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



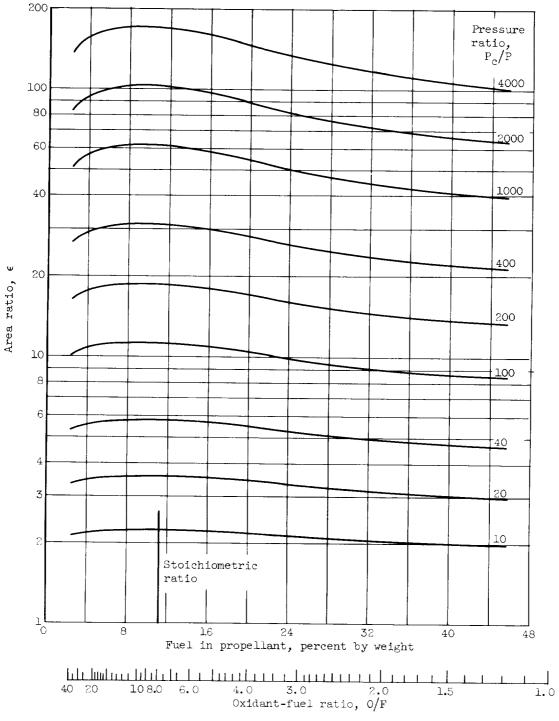
(c) Chamber pressure, 150 pounds per square inch absolute; frozen composition during expansion.

Figure 3. - Continued. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



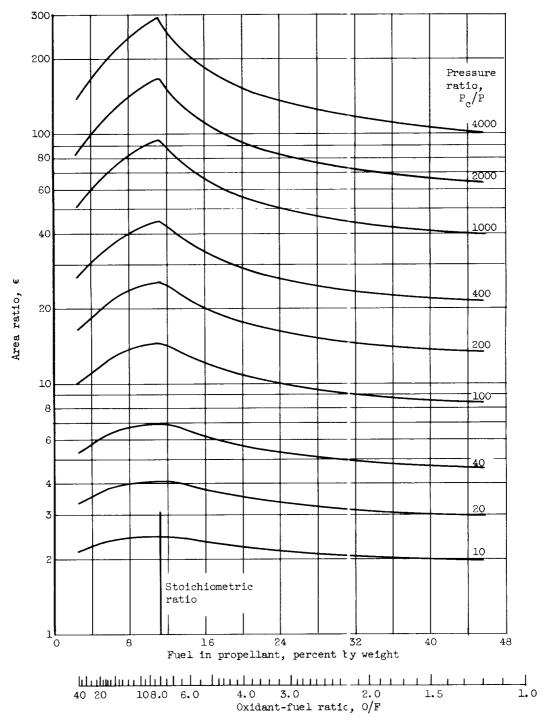
(d) Chamber pressure, 150 pounds per square inch absolute; equilibrium composition during expansion.

Figure 3. - Continued. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



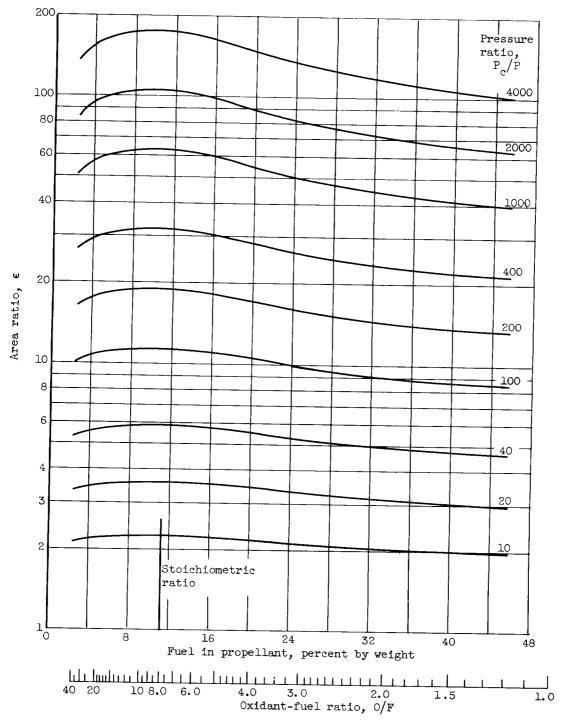
(e) Chamber pressure, 300 pounds per square inch absolute; frozen composition during expansion.

Figure 3. - Continued. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



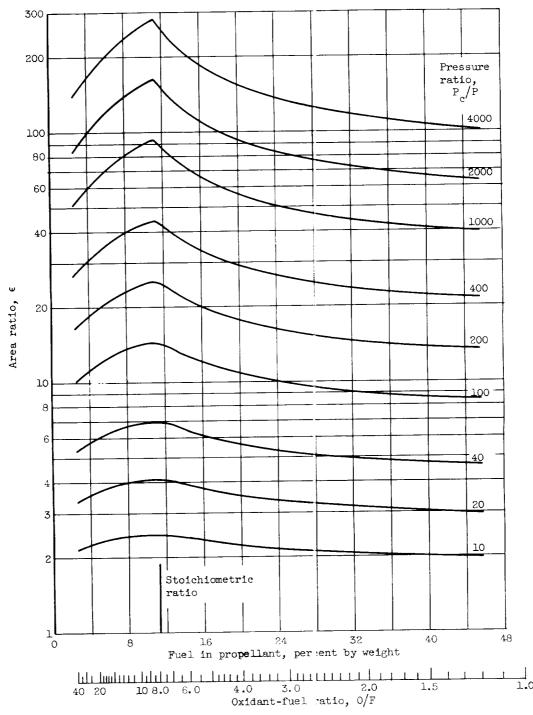
(f) Chamber pressure, 300 pounds per square inch absolute; equilibrium composition during expansion.

Figure 3. - Continued. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



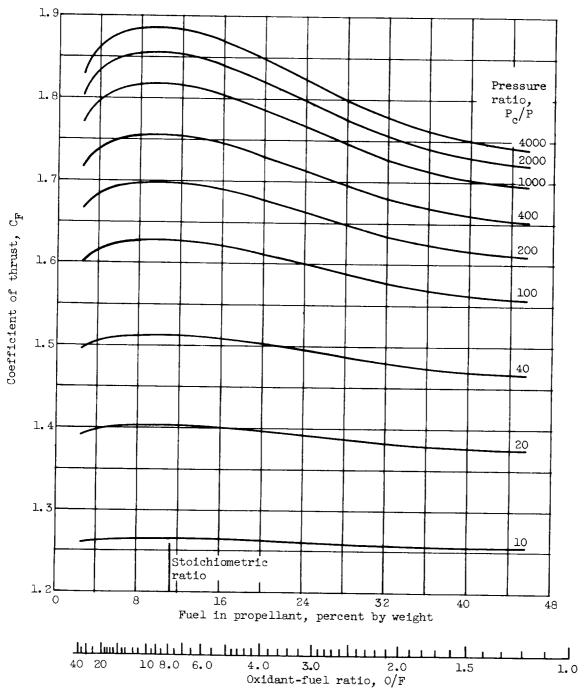
(g) Chamber pressure, 600 pounds per square inch absolute; frozen composition during expansion.

Figure 3. - Continued. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



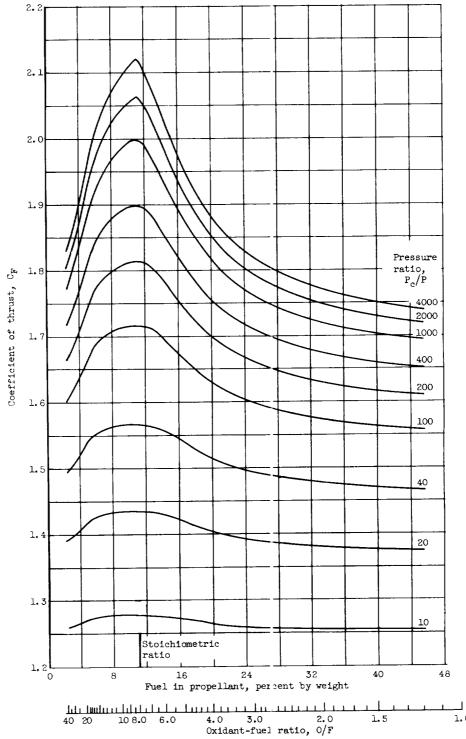
(h) Chamber pressure, 600 pounds per square inch absolute; equilibrium composition during expansion.

Figure 3. - Concluded. Theoretical ratio of nozzle area to throat area for liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



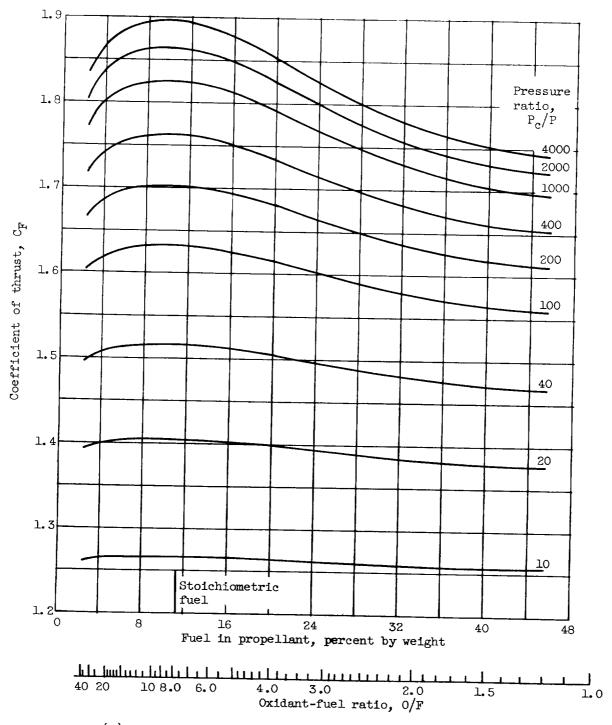
(a) Chamber pressure, 60 pounds per square inch absolute; frozen composition during expansion.

Figure 4. - Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



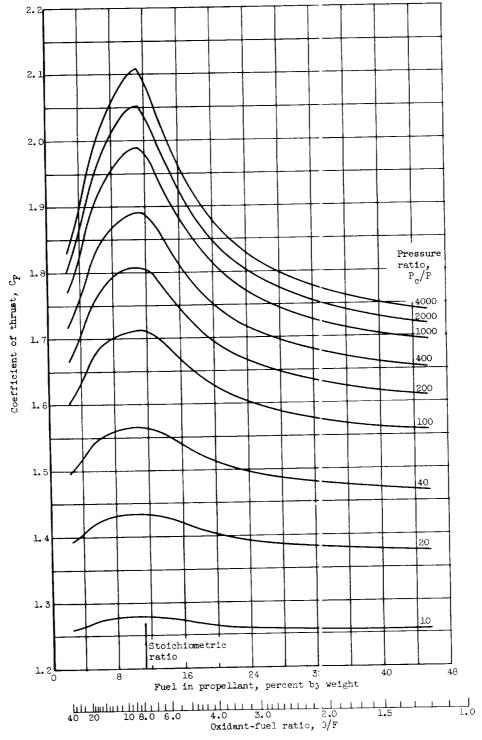
(b) Chamber pressure, 60 pounds per square inch absolute; equilibrium composition during expansion.

Figure 4. - Continued. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



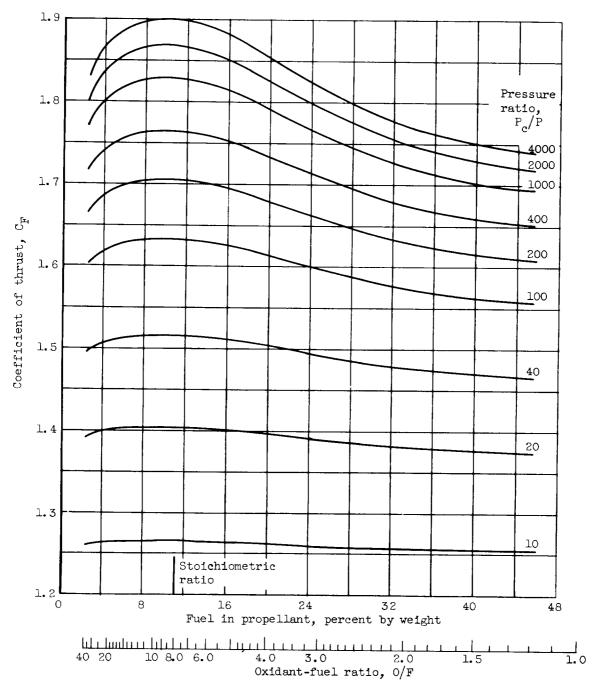
(c) Chamber pressure, 150 pounds per square inch absolute; frozen composition during expansion.

Figure 4. - Continued. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



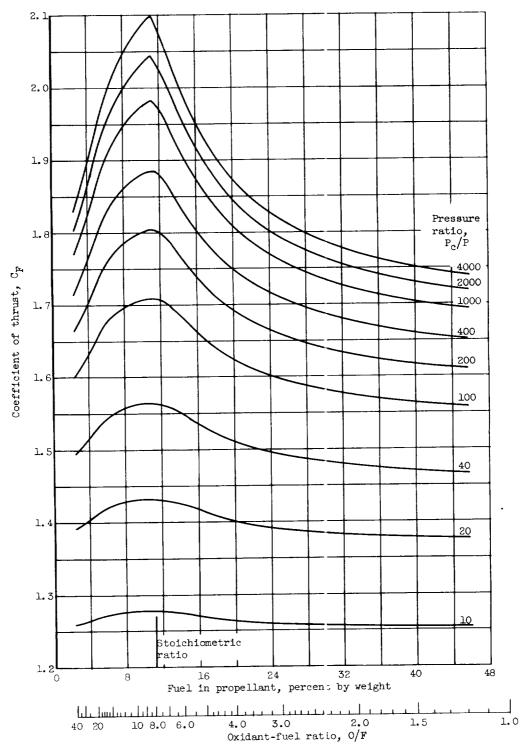
(d) Chamber pressure, 150 pounds per square inch absolute; equilibrium composition during expansion.

Figure 4. - Continued. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



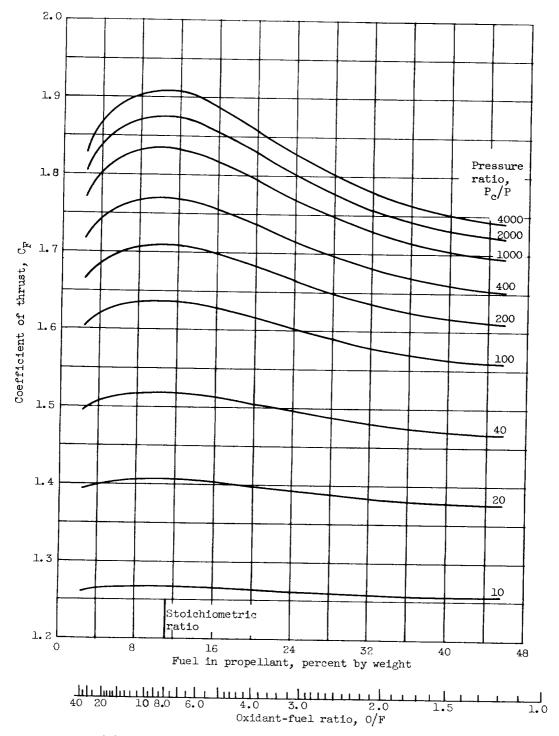
(e) Chamber pressure, 300 pounds per square inch absolute; frozen composition during expansion.

Figure 4. - Continued. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



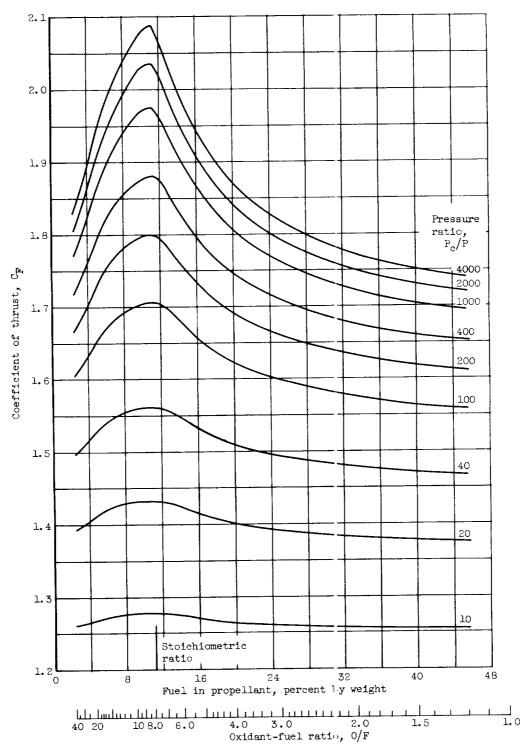
(f) Chamber pressure, 300 pounds per square inch absolute; equilibrium composition during expansion.

Figure 4. - Continued. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



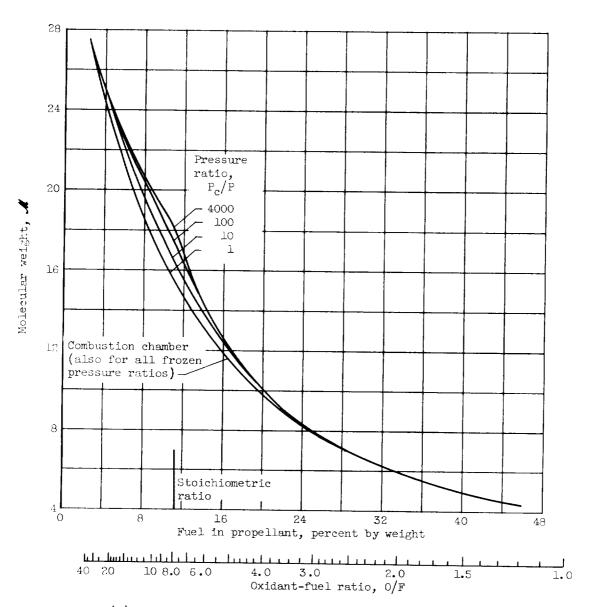
(g) Chamber pressure, 600 pounds per square inch absolute; frozen composition during expansion.

Figure 4. - Continued. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



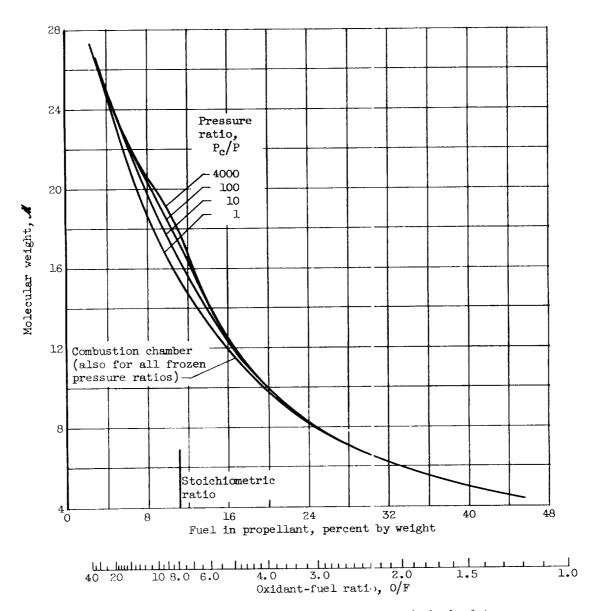
(h) Chamber pressure, 600 pounds per square inch absolute; equilibrium composition during expansion.

Figure 4. - Concluded. Theoretical coefficient of thrust of liquid hydrogen and liquid oxygen. Isentropic expansion to pressure ratio indicated.



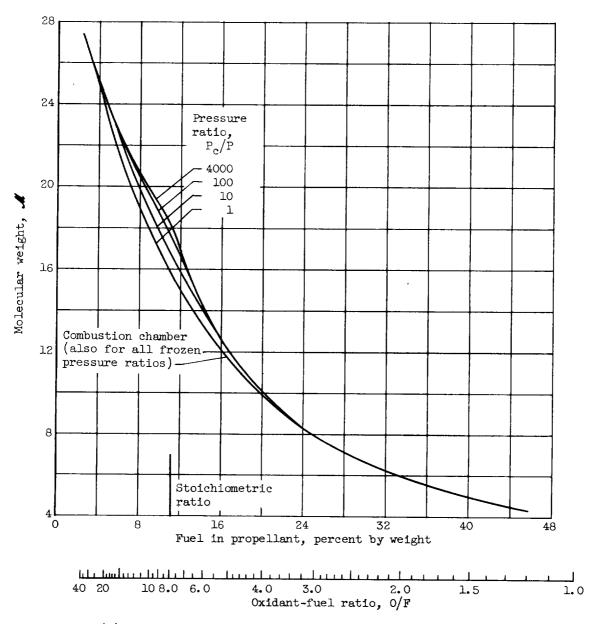
(a) Chamber pressure, 60 pounds per square inch absolute.

Figure 5. - Theoretical molecular weight of liquid hydrogen and liquid oxygen. Equilibrium composition during isentropic expansion to pressure ratio indicated.



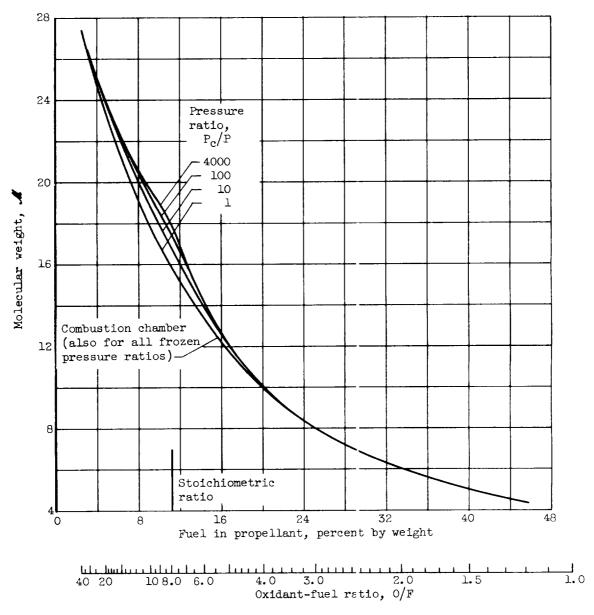
(b) Chamber pressure, 150 pounds per square inch absolute.

Figure 5. - Continued. Theoretical molecular weight of liquid hydrogen and liquid oxygen. Equilibrium composition during isentropic expansion to pressure ratio indicated.



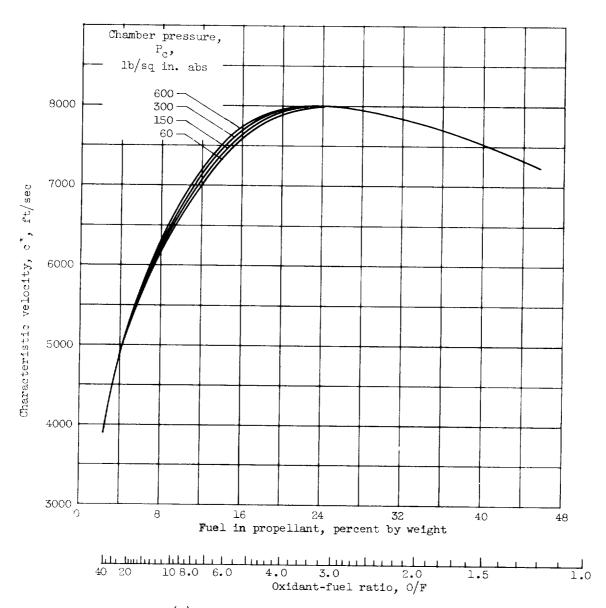
(c) Chamber pressure, 300 pounds per square inch absolute.

Figure 5. - Continued. Theoretical molecular weight of liquid hydrogen and liquid oxygen. Equilibrium composition during isentropic expansion to pressure ratio indicated.



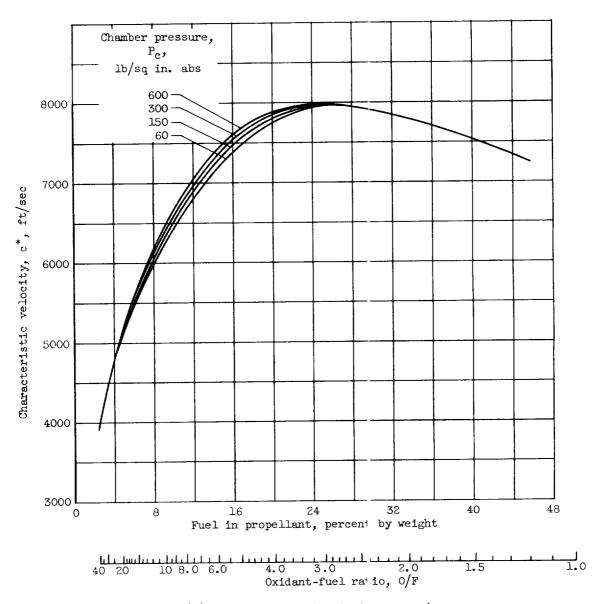
(d) Chamber pressure, 600 pounds per square inch absolute.

Figure 5. - Concluded. Theoretical molecular weight of liquid hydrogen and liquid oxygen. Equilibrium composition during isentropic expansion to pressure ratio indicated.



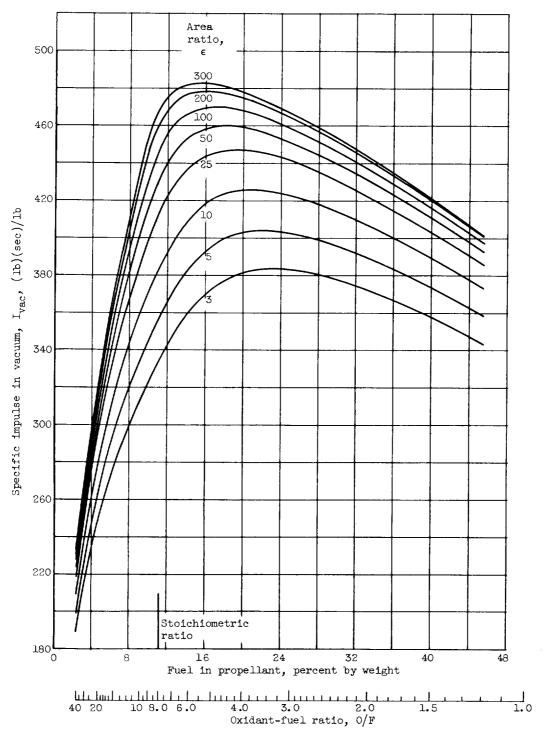
(a) Equilibrium composition during expansion.

Figure 6. - Theoretical characteristic velocity of liquid hydrogen and liquid oxygen.



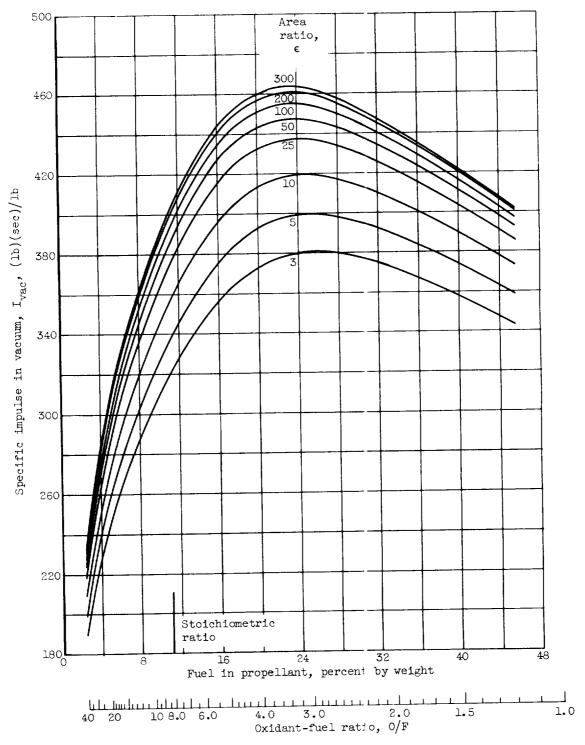
(b) Frozen composition during expansion.

Figure 6. - Concluded. Theoretical characteristic velocity of liquid hydrogen and liquid oxygen.



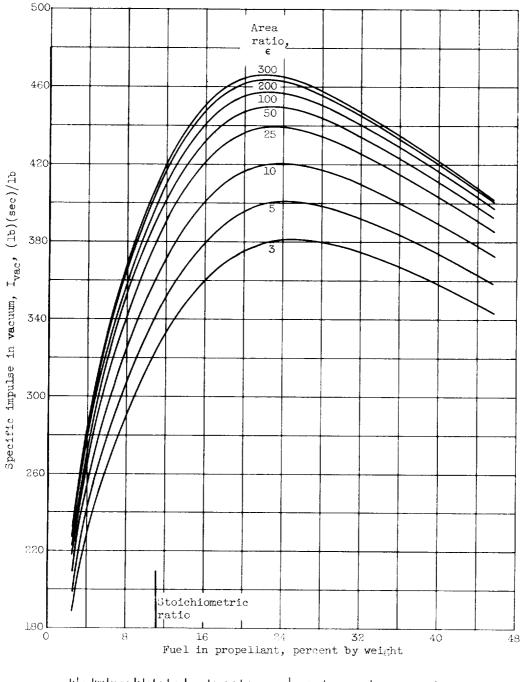
(b) Chamber pressure, 60 pounds per square inch absolute; equilibrium composition during expansion.

Figure 7. - Continued. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to area ratio indicated.



(a) Chamber pressure, 60 pounds per square inch absolute; frozen composition during expansion.

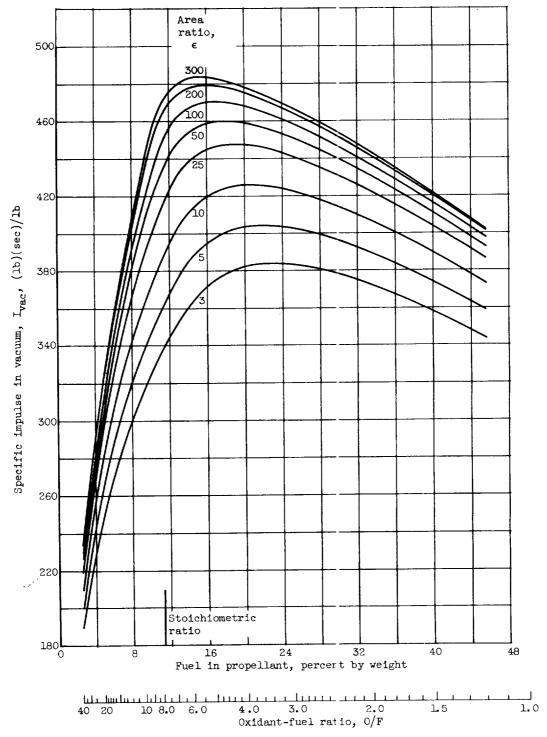
Figure 7. - Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to are a ratio indicated.



40 20 10 8.0 6.0 4.0 3.0 2.0 1.5 1.0 Oxidant-fuel ratio, O/F

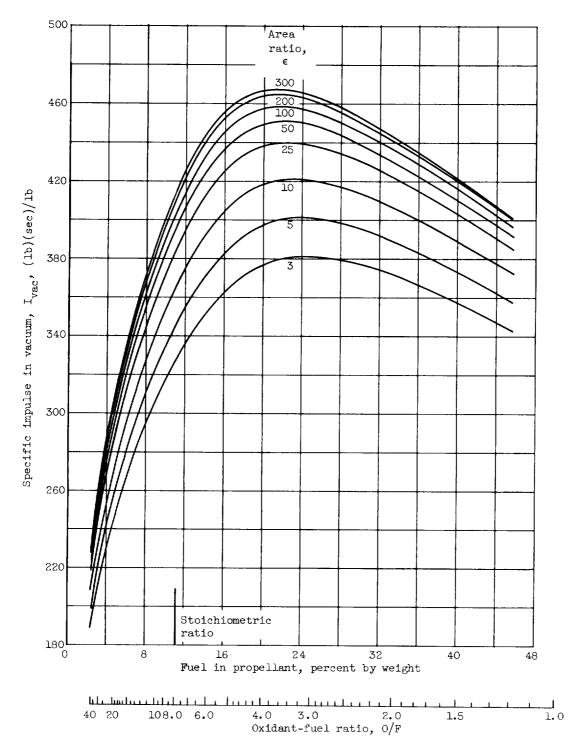
(c) Chamber pressure, 15:0 pounds per square inch absolute; frozen composition during expansion.

Figure 7. - Continued. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to area ratio indicated.



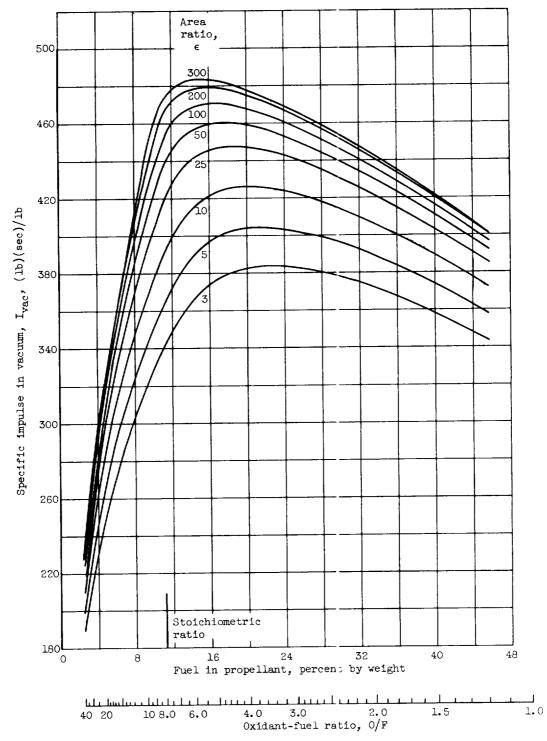
(d) Chamber pressure, 150 pounds per square inch absolute; equilibrium composition during expεnsion.

Figure 7. - Continued. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to area ratio indicated.



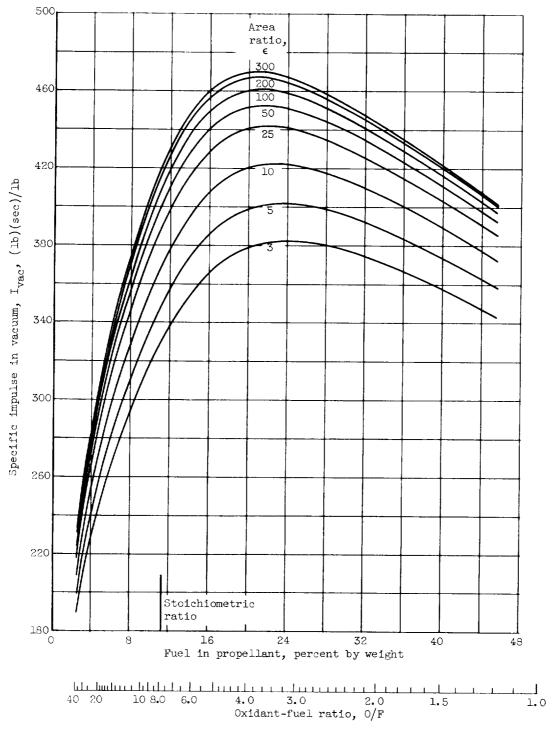
(e) Chamber pressure, 300 pounds per square inch absolute; frozen composition during expansion.

Figure 7. - Continued. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to area ratio indicated.



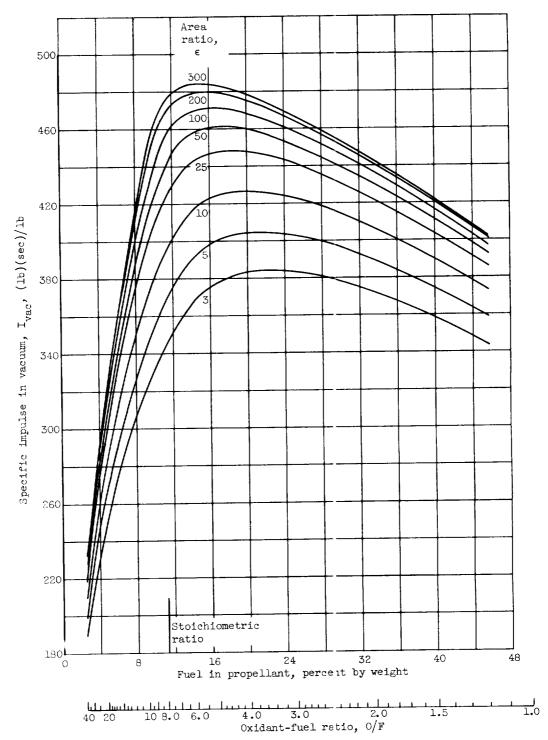
(f) Chamber pressure, 300 pounds per square inch absolute; equilibrium composition during expansion.

Figure 7. - Continued. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to area ratio indicated.



(g) Chamber pressure, 600 pounds per square inch absolute; frozen composition during expansion.

Figure 7. - Continued. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic expansion to area ratio indicated.



(h) Chamber pressure, 600 pounds per square inch absolute; equilibrium composition during expansion.

Figure 7. - Concluded. Theoretical specific impulse in vacuum of liquid hydrogen and liquid oxygen. Isentropic ϵ xpansion to area ratio indicated.

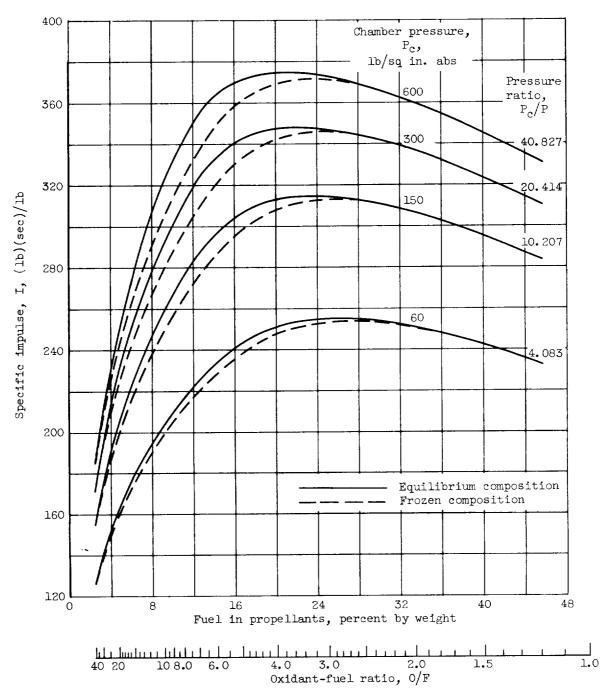


Figure 8. - Theoretical specific impulse for liquid hydrogen with liquid oxygen. Isentropic expansion to 1 atmosphere from chamber pressure indicated.